AD NUMBER
ADA491838
CLASSIFICATION CHANGES
TO: **UNCLASSIFIED**
FROM: **RESTRICTED**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to DoD only; Foreign Government Information; OCT 1950. Other requests shall be referred to British Embassy, 3100 Massachusetts Avenue, NW, Washington, DC 20008.**
AUTHORITY
DSTL ltr dtd 16 Feb 2007; DSTL ltr dtd 16 Feb 2007

MINISTRY OF SUPPLY

PERMANENT RECORDS
of
RESEARCH AND DEVELOPMENT

SAFETY IN ROYAL FILLING FACTORIES

By P. E. MASTERS

MONOGRAPH No. 15·350

Issued by the Chief Scientist
Ministry of Supply, Shell Mex House, Strand, London. W.C.2.

(OCTOBER, 1950)

MINISTRY OF SUPPLY

PERMANENT RECORDS OF RESEARCH AND DEVELOPMENT

No. 15·350

SAFETY IN ROYAL FILLING FACTORIES

By P. E. MASTERS

Officer Responsible:
Director - General of Ordnance Factories

Printed at I.E.M E.

TABLE OF CONTENTS

APPENDICES

ABSTRACT

The contents of this monograph give, within the limits considered desirable, a brief record of some of the history of accidents in filling factories, the methods adopted to satisfy the safety principles laid down, and the results achieved during the War period. Some notes of future lines of development are also given. The main inclusions cover safety from Fire or Explosion, but ordinary industrial safety, with figures for all accidents, is all dealt with briefly.

References are given in the appendices to accident reports, Instructional Memos. etc.

SECTION 1

OBJECT

To record methods and precautions taken to ensure safety in Filling Factories, and to make recommendations for the future.

SECTION 2

HISTORY

The history of Explosives safety in R.F.F.'s no doubt commences with the first accident experienced in ammunition filling, and most precautions in use have been based upon experience with such accidents. However one may look ahead and try to foresee accidents, with an eye to prevention, they still occur and something is learned from each one if it is properly investigated. Woolwich commenced filling some time in the 18th century and Appendix A of this monograph is a replica of what is probably the earliest 'safety rule' in existence and is especially interesting inasmuch as it advises upon safety in method and also limits the amount of explosives to be before an operator, graduated for different sizes of fuze etc. in process. Present day Superintendents' Safety Orders contain similar rules, but are much more comprehensive.

In Vincent's 'History of Woolwich', a number of accidents which occurred in the Royal Laboratory are described. This was the first recorded Government Filling Factory.

In 1845, for instance, 7 people were killed when breaking down gunpowder filled fuzes, and arising out of the enquiry three regulations were formulated

(a) That Danger Building doors must open outwards.

(b) That copper knives should replace steel.

(c) That no nails should be permitted in boots worn in filling shops.

Thus these three fundamental rules clearly preceded the issue of the Explosives Act of 1875, which as far as is known is the first comprehensive legal document controlling the manufacture and filling of explosives from the safety aspect.

No doubt this Act was based upon experience gained at Woolwich and at firework factories and Gunpowder Makers' works. (There appear to have been many makers of Gunpowder well before this time, as there is in existence a copy of a petition to the King, begging him to permit sales of salt petre by the East India Company, in 1790, signed by six manufacturers and addressed from the "Gunpowder Office" in Birchin Lane, London)

The Act goes into considerable detail in regulating work on explosives, and although it covers all the types then in use for various purposes, the Royal Laboratory used little but Gunpowder and Fulminate of Mercury, as Gunpowder was then the shell filling and the propellant for gun ammunition.

Clause 97 of the Act excludes any Crown factory from its application, but in controlling safety from every aspect where the Act might be applicable it is in fact followed in principle, or at least borne well in mind.

Regulations for Danger Buildings, following similar lines, but strictly applicable only to the work in R.F.F.'s, have been in existence over a great number of years, and are revised from time to time. The latest revision was in 1943.

Last War Accident Records

During the Great War of 1914/1918, a permanent Government Committee was set up for the investigation of Explosives Accidents under the Chairmanship of Col. Nathan, and their reports of major accidents are available, together with a useful report on the Safety aspects of certain explosives then in use. This latter was brought up to date in 1944 to cover current practice. (Appendix B)

New Factory Planning

Between wars, the War Office appointed a committee to deal with the planning of three permanent factories for Ammunition Filling, the factories situated at and named Chorley, Bridgend, and Glascoed. These were planned on substantial lines, and were designed at Woolwich by the Engineer in Charge, who was a member of that Committee. Magazine Regulation distances were the basis of Magazine planning, and the Regulation distances for work shops were based upon Home Office tables (See Appendix K of Explosives Act). Small workshops were sometimes grouped as a basis of Explosives distances in planning. Advantage was taken of previous accident experience in planning these factories and certain special trials were staged to ascertain effect of explosion on underground Magazines. (See C.S.A.R's report, Glascoed trials).

On the outbreak of War in 1939, it became evident, from programmes drawn up by the Services, that several more large temporary factories were required. Planning was urgently necessary, so these temporary factories were planned on very similar lines, except that considerable reductions in the spacing of buildings in certain groups were made, and the buildings were of a more temporary nature (e.g. 4.1/2-in. brick walls). The reductions in spacing were the result of long experience of the effects of explosions in filling, and incidentally resulted in a considerable economy in cost of cleanways, services, roads, railways, etc. the necessity for which economies was by then being stressed. Experience during this War has indicated that these reductions in distances were fully justified and that further such action can, in certain instances, be taken. (See Development - Recommendations for future).

The History of ordinary industrial safety in Filling Factories

This is much the same as that for industry in general. Much work has been done without great success, to reduce the large number of small accidents.

Records exist from 1941 to 1945. Up to June 1944 the records were not made in full conformity with the International Scheme but since that date they conform fully (see under 'Results').

SECTION 3

METHODS

General principles and requirements of explosives safety

These are to ensure, as far as possible, that:

(1) Nobody outside a Filling Factory is likely to be injured by an explosion therein.

(2) Types of risk are kept separate.

(3) An explosion or fire in any one building will not be communicated to the next or any other building or to workers in those buildings.

(4) As few people as is consistent with economy in output and building cost, are exposed to any one explosive risk.

(5) Inside any one building, the more dangerous processes are segregated and guarded, so that workers not so engaged are not exposed to these risks.

(6) The individual necessarily exposed to the more serious risks is protected as far as possible.

(7) All workers are given the maximum protection against fire.

(8) Explosives are protected from such hazards as Lightning, Static Electrical discharges, etc.

(9) Any ignition is quenched in its initial stages and/or an explosive effect kept to a minimum.

(10) Operatives are made fully aware of the relative risks to which they are subjected on the operations on which employed.

(11) That service designs of stores are safe to fill and transport before design is sealed.

To meet the above conditions,

(1) "Outside distances" quoted in the Magazine Regulations are rigidly adhered to, or alternatively the consent of the occupier of adjacent property is obtained, and safety provision is made for him as far as possible. These distances are necessary and are carefully observed in planning.

(2) Factories are divided into groups, so that the risks of toxicity are reduced if possible to one type, and the risk of explosion similarly. It would obviously be bad practice e.g. to mix gunpowder work with C.E. Pellet pressing, or to expose detonator carriers to the risks of Cleanways on which heavy trucking passes.

Major Groups are usually as follows:

Initiator Filling	Small quantities of the most sensitive explosives. Ignitions frequent, but extremely local in effect.
Booster Filling (C.E.pellets or bags)	Comparatively small quantities of medium sensitivity. Ignition infrequent.
Fuze Filling	
(a) Time (Gunpowder) (b) Peron. (C.E.Magazine) (c) Gaines (C.E.Magazine)	Medium risks. Ignition infrequent.

Propellant preparation and Complete Round Assembly	Serious fire risk Ignitions infrequent.
Smoke Filling	Medium fire risk
Small Arms Ammunition Filling	Slight local risks
H.E.Shell & Bomb filling	Large quantities. Infrequent ignitions but effects serious
Pyrotechnic Filling	Rather high risk of fire and explosion. Ignitions fairly frequent.

The above groups are in certain cases further sub-divided. Thus, mixing of compositions is segregated from filling shops, and cordite cutting from tying, and from Complete Round Assembly.

Note. It is undesirable generally to convert groups from one type of work to another and, if projected, a very thorough decontamination would be necessary.

(3) This is achieved by spacing buildings according to standard limits. Mounds or traverses are used where necessary between buildings. In addition, fire alarms, fire walls, fire hydrants with hose boxes, etc. are provided at frequent intervals and an auxiliary fire brigade is trained and always available during working hours. Little inflammable material is used in construction of buildings. Light roofs are provided in workshops to avoid dispersal of heavy debris. Light blow-out walls or panels are also used. Inspectors of Danger Buildings are employed to see that the Explosive Limits laid down are not exceeded, and that the work is performed according to Superintendent's Safety Orders, which are posted in every shop. A ring main for fire purposes runs round the factory and is tapped at intervals, and so arranged that an explosion which may damage part of the main does not put the system out of action. Buildings are as far as possible staggered on either side of a clearway, so that porches are not opposite, and flame or blast from one will not enter another.

(4) Initially this is controlled by the size of the shop which is planned for some specific or general purpose, to give an economical output. Requirements, however, change frequently, and new internal layouts are necessary. It is at this stage generally that the best efforts of those responsible for safety can be made. Man and explosive limits must be kept low and need not necessarily be as high as the building situation permits.

No workshop may ever be used as a store, or allowed to contain more explosive than is absolutely necessary for the operations to be performed therein. No store may ever be used as a workshop. No explosives, especially in drying processes may ever be maintained at a higher temperature than is necessary, or, at the proper temperature, for a longer period than is necessary.

New layouts are submitted to the Superintendent (after the proper 'flow' and balance of operations has been

determined) to examine from the safety aspect. These new layouts, if unusual, are submitted to Headquarters also.

Storage buildings and some others have been protected against external attack by incendiary bombs, by the provision of a 6-in. concrete roof, but this is not suitable for filling shops, which should have a light roof. A heavy roof presents extra hazard in the event of explosion. Light blow out walls are often desirable.

(5) The more hazardous processes are protected by internal traverses or shields. Where possible the operator is also protected; but where impossible the number is reduced to the absolute minimum who must be so exposed. An example is a detonator filler, who must enter the filling compartment, but no other person is allowed to enter. The carrying of hazardous explosive in workshops is reduced to the minimum by the use of suitable hatchways.

(6) As much of the work as can be, is done from behind a shield or guard as in the case of a detonator filler, or an extruder machine operator. Shields or guards are designed by the Factory or H.Q. Engineering Department and are then "type tested". This usually involves exploding within the guard, under suitable precuations, the particular type of article to be dealt with therein, augmented if possible by about 50% more explosive, to ensure that the guard is adequate. When this is confirmed, the guard has stencilled upon it a legend indicating exactly what it is designed to withstand.

(7) Special clothing for all explosives workers is provided. Standard tests for "fire-proof" clothing have been evolved and are used for new consignments of cloth or to test clothing after "fire proofing". These tests are of course only comparative, but experience has shown that great protection can be afforded against flame by proper garments and these have made a great difference in degree of burning suffered by operatives when pyrotechnics have ignited. Samples are to be seen in the Home Office Museum. (Appendix C)

All doors open outwards and special escape doors are provided as necessary.

(8) Lightning rods are provided on every explosives building and risks of static electrical discharge are taken care of (see separate monograph No. 15351).

(9) Every building is provided with fire buckets, and some have hand pumps. Where necessary, drenching systems are arranged, and fire curtains of water from spray nozzles. Quantities of explosives in operation are kept to recognised maximum quantities at each operation.

(10) This is achieved (a) by proper training, in which all workers are given clear instructions in what they should and should not do and are, where possible, practiced in the actual processes, first with inert material and then with the explosive, (b) by demonstrations to workers, on the burning ground, of the effects of ignition of explosives, and (c) by the issue of Superintendent's Safety Orders which are posted in every shop and which again give, for reference, the necessary guidance for safety in working.

(11) Examination is made of all preliminary designs by A.D.F.F.(P) to ensure that safe methods of filling can be devised. Not infrequently modifications are suggested and accepted.

Other Methods of Assisting in Safety

(A) Clean Conditions are maintained by the use of cleanways connecting all shops, and entrance to the cleanways is controlled. All workers, staff and visitors must enter by the shifting house, the workers changing clothes and shoes, others putting on magazine shoes or over-shoes. The psychological effect of wholly clean conditions is considerable and has a definite bearing upon safety.

All means of procuring a naked light in the Danger Building Area are normally forbidden, but where such a light is essential special permission has to be given and strict regulations as to method are laid down. (See Rules of Danger Area)

(B) Safety Certificates.C.S.A.R. provides, for every explosive, and composition, (initiator or pyrotechnic, smoke, etc.) a "safety certificate" which gives details of the principal characteristics of the particular materials and their behaviour under standard tests. Copies are made and circulated to all factories concerned to enable Superintendents to judge the type of layout necessary, quantities to be handled etc. etc.

Summaries are made of the essential points from these certificates for ready reference.

(C) Incompatibility of various metals with explosives. This matter is normally dealt with by means of the C.S.A.R. Safety Certificate, but as there are so many of these and factories may not always consult them sufficiently frequently, a list of Explosives and metals showing degree of incompatibility was prepared by this Department. C.S.A.R. has a check of this in hand and will be asked periodically to bring it up to date. Copies are issued to all factories. (Appendix D).

(D) Courts of Enquiry. For accidents which are serious and in any way mysterious the Home Office Chief Inspector of Explosives has, during the War, been called in to preside at the Court, and the Director General of Filling Factories or his nominee attends, together with such experts as may be decided.

For less serious or less mysterious accidents a No.2 Court is held at which the Military Assistant to the Director General presides or arranges a President from his staff of Inspectors of Danger Buildings, and in still less serious cases the Factory Superintendent presides.

Report is made to the Director General and the Director responsible for safety examines the report and takes action to implement the recommendation in such ways as he thinks desirable (see Filling Factory Instructional Memo. No. 225). (Appendix E)

Accidents other than explosives accidents are investigated by the Superintendent or his nominee, individually and in classes, and the Factory Safety Committee reviews them monthly, and takes preventive action.

(E) Accidents are listed and analysed into types. The lists are reviewed periodically and where a type recurs frequently special action is taken; e.g. the 5 grn. A.S.A. detonator gave so much trouble, that, after having taken all the anti-static and other precautions we could devise, the Ordnance Board were approached to replace it by another type.

(F) Safety Officers. Each Filling Factory has a Safety Officer whose duties are to advise on action necessary and to take follow up action on Form 618 from Headquarters (See 'I' below).

(G) Safety Committees. The Factory Safety Committee investigates all accidents monthly, and either initiates action or advises Superintendents on action considered desirable (Terms of reference and constitution are appended) (Appendix F).

(H) The Headquarters Safety Committee is a sub Committee of the Welfare Committee Ministry of Supply and is presided over by P.A.S./L. Their function is to co-ordinate action on all Ministry of Supply Factories.

Filling Factories Safety is taken care of by the Author who is a member of the Headquarters Safety Committee, and has to assist him an Assistant Director for this work. The latter holds regular meetings of Factory Safety Officers, to disseminate information and to discuss safety matters generally.

(I) Records of Action Taken. Every report of a Court of Enquiry is considered at Headquarters and action necessary is decided upon. Most often it is possible to give consise instructions as to action to be taken, in which case a report is called for in one month, and is followed up until completed. Where common action is not possible, or can best be left to the discretion of the Superintendent the form is marked "for information" (See Form 618) (Appendix G).

(J) As a help to Superintendents, M.A./D.G.O.F. has an Inspector of Danger Buildings on each Factory to see that the Superintendent's Safety orders are adhered to. These officers, as they become experienced are able to offer advice on occasions, but have no administrative or executive authority except over their own Danger Building Visitors. These D.B.V's pay regular visits, carry out searches etc. They are in the nature of a Police Force to ensure that rules and regulations are obeyed, and as such are independent of the Superintendents' direct control. This arrangement has worked well and has distinct advantages.

(K) Destruction of waste or unserviceable explosives. Special precautions are necessary in preparing, laying out and igniting such explosives, and reference should be made to the standard instructions in use at R.O.F.s. After a series of accidents a special meeting was called at which C.S.A.R., I.C.I. and D.G.F.F. were represented and the minutes and decisions of this meeting are available.

(L) Returns of Explosives Limits in buildings in excess of Regulations. It frequently happens, both in war and in peace, that changes of programme, introduction of new War stores etc. involve factories in the necessity for temporarily exceeding approved explosives limits in Magazines or Workshops. Superintendents are empowered to approve such temporary increases but report position regularly to Headquarters for covering approval or suggestions to avoid continuance thereof. Some types of explosives and some types of buildings cause less concern than others, and with the former a temporary excess over Regulations Limits can be allowed for a considerable period, without serious risk. Judgment has to be exercised, and in war time of course unusual risks have on occasion to be accepted.

(M) Ducting and Filters. Explosive dust represents two hazards. It is more inflammable than bulk explosive and has a higher toxic effect. Wherever possible therefore, dust is extracted by fans or induced draught and the dust is collected in oil or water filters, which are periodically emptied. Ducts are made with suitable doors to facilitate regular cleaning. An instructional Memo. has been issued

and a separate monograph covers this subject (No. 15504) (Appendix H).

(N) Certification of freedom from Explosives. Some trouble has arisen, periodically, with the issue of shells, bombs, packages, machines or containers from a danger area, either to Engineering Workshops within the factory or to outside contractors. This usually arises either from incomplete removal of all explosives, or from an occasional "live" round or package amongst a consignment of empties. To avoid this, as far as possible, a very careful drill has been instituted and matters have improved. Instructional memos. dealing with the subject have been issued together with a pamphlet printed by R.F.F. Thorp Arch.

(O) Decontamination of Factories, Groups or Individual Buildings, no longer required for Ammunition Filling work and to be handed over to other Industries. Experience in R.F.F.'s has indicated certain specific dangers existing in incompletely decontaminated factories, and the possibility of other hidden dangers (see reports F.315 and F.321 on accidents at Thorp Arch dated 29.3.45 and Swynnerton dated 19.3.45).

Later, after Burghfield factory had been handed over for storage, certain quantities of explosive and dangerously contaminated floors were discovered and a final clean up had to be instituted.

The matter was therefore carefully considered and a brochure prepared giving guidance to factories on this matter. (Appendix J).

(P) Special methods have been devised to reduce risks. These are many and cannot be detailed, but an example of this is the proposal to sink 8 lb. bombs into wooden trays to avoid sympathetic detonation should one explode. C.S.A.R. carried out trials at our request and discovered that a few inches of wood sufficed whereas 18-in. of air space was necessary.

(Q) Special colour schemes for receptacles for sensitive compositions, to avoid errors or dangerous contamination, are used. Marking of benches for exact arrangements of receptacles and tools is also adopted after careful study of the safest method of handling.

SECTION 4

RESULTS

Explosives Accidents

Records obtained during this war indicate that the rate of explosives accidents has been satisfactorily low.

The frequency rate has averaged, over the two and a half years prior to June 1945, for which accurate records exist, less than 0.22 per 100,000 hours worked. No such figure is available for the last war. The Severity Rate for Fire and Explosive Accidents for 1944 was 416 hours lost per 100,000 man-hours.

The following extract, however, from the annual report of the Chief of Ordnance U.S.A. published in the Ordnance Digest of August, 1945, is of interest as comparison...

"....Although the accident rate for Government-owned Ordnance installations had touched the remarkable low of 5.6 per million man-hours worked in July, 1944, the rate improved constantly, and by May,

1945, had dropped to 4 per million man-hours, a 28.6 per cent reduction. The combined rate for Government-owned and privately-operated Ordnance establishments made an even greater decline - 32.8 per cent below the July, 1944 rate of 3.8 /million hours...."

It therefore seems clear that our accident frequency on this type of work compares favourably with that in the U.S.A. and is of the same order.

The total number of civilian employees in U.S.A. Ordnance Factories (page 14 of same publication) was about 180,000 and is again of the same order as ours which reached about 150,000.

Fatalities

During the last War (1914/18) several very serious accidents occurred (e.g. Chilwell 134 fatalities) involving large casualty lists and much damage to buildings.

In this war, the maximum number of fatalities in any one accident has been 9, which occurred at Kirkby in September 1944 on Clustering 8-lb. bombs and was due in all probability to a defective empty fuze. Incidentally this accident demonstrated the need for fully steel framed buildings, as much less structural damage and probably fewer casualties would have resulted had such framing existed throughout. (See Accident Report No. F.255).

The next serious accident from the point of view of fatalities was 8 at Aycliffe in May 1945, when an extruder machine blew up whilst filling 4.2 Mortar Bombs. This extruder had been an addition to the original layout (in which one machine only was included, and was behind a stout traverse with remote control) and had practically no protection. It had been added to meet urgent war time requirements and did not therefore represent a normal condition.

This demonstrated the need for proper internal protection of operations, as the casualties would then have been restricted to one or two.

The only accident involving more than one building in any serious degree took place at Herefore (2 fatalities only). This factory had no inter-shop mounding and was built in the 1914/1918 war for shell filling work in special cubicles, but had been adapted for large bomb filling, in the open shop, outside the cubicles, to meet urgent operational requirements. In 1939 a mound had been built to separate the H.E. filling group from the administrative and cartridge assembly portions of the factory, and this proved quite effective, but there was no room to build inter-shop mounds, so that the damage in the H.E. group was extensive. This merely proved the necessity for proper mounding and spacing of H.E. filling shops, as normally arranged (Reports on these accidents, with photographs exist).

During the 1914/1918 war so far as can be traced 301 deaths occurred in 4 years, at an average of 75 per annum. During this war, to date, (1940 - mid 1945) 90 deaths have occurred in 4.1/2 years, an average of 20 per annum.

Both exclude Woolwich, and may not be strictly comparable figures, but are sufficiently indicative.

A complete list of explosive accidents is appended and copies of all reports and actions are available in the Department. (Appendix K).

Total Accidents

The frequency rate for all accidents, (ordinary Industrial type plus explosives accidents) for the period 1943/44 averages 3.01 accidents per 100,000 hours worked.

When it is realised that work was on 3 shifts, so that much of it was performed during the black-out period when minor accidents were frequent, and that workers of all ages were employed, many of whom had no former industrial experience whatever, the figure is considered to be good.

The severity rate for all accidents for the period 1943/44 averaged 1,113 hours lost per 100,000 hours worked.

Fatalities, (which count 48,000 hours or about 20 working years of time lost) are probably more frequent in an explosive loading factory than in Industry generally, and naturally tend to raise the severity rate, which, however, is no higher than in many industries usually looked upon as less hazardous.

General Review

Only approximately 7% of all accidents in R.F.F.s are due to fire and explosion as may be seen from the attached graphs. (Appendix L).

Taking a general view of the results it can be said that they are satisfactory but naturally there is still room for improvement. Safety devices of many sorts have been developed continuously at all factories and by the appropriate Headquarters Departments, and have contributed appreciably to the results obtained. Under peace-time conditions, when the same urge to take avoidable risks does not exist, the figures might appreciably improve.

A table of fatalities is appended and also total figures for the years 1943 and 1944. (Appendices M and N).

It is not possible to record all safety devices installed but most are recorded in designs held by D.F.F.(E. & S.) or in factory files, and many can be traced from recommendations of Courts of Enquiry.

Note. The system of recording Frequency and Severity Rates as recommended by the International Labour Office is used.

Clearing Explosive Debris left after an accident.

It happens not infrequently that an explosion of ammunition leaves some appreciable quantities unexploded, and in a dangerous or at least a possibly dangerous condition. Such occasions call for very special care, and the best advice available from experienced officers, either within or without the organisation, should be sought.

It becomes a "bomb disposal squad" job, but can usually be tackled by a squad enlisted from the factory staff. As an indication of the type of job under discussion and the methods adopted to handle it, reference should be made to the reports on the clearing of the Hereford site after the explosion of 30.5.44, and to that of the Kirkby site also after the explosion of 15.9.44, both of which were highly hazardous operations carried through without further accident.

Copies of these reports are available in this Department.

SECTION 5

FUTURE DEVELOPMENT

Buildings

Some small movement towards larger workshops than those at Chorley, especially for cordite work, Small Arms Filling, and detonator filling took place amongst the later-built factories (e.g. Aycliffe) where some of these buildings were doubled or even quadrupled in size. For future planning, based on a long experience the following points may be given consideration.

Semi-clean conditions

This method, that is, clean shops connected by roads or platforms not kept clean, has some advantage in economy of construction. Boot boxes become necessary at the shop entrance, however, and some difficulties in working are experienced where more than a few workers are employed per shop. The general opinion when last considered was that it was hardly worth while, and that a better control of safety was possible with wholly clean conditions, but the U.S.A. and most continental countries work under semi-clean conditions and I.C.I. in this country adopt it for much of the Small Arms filling, for which it is eminently suitable. There is, as stated earlier, a definite psychological effect upon workers under wholly clean conditions which perhaps should not be lost.

Building Types and spacing

(i) For all heavy H.E. filling work, buildings should be properly spaced according to the explosive content allowed, and should be mounded for protection. Good walls fully steel framed with a light roof are best, with internal traverses as necessary.

(ii) Small H.E. Filling say 25-pdr. shell and small sizes of shells and bombs, where an explosion en masse is unlikely and can be avoided by proper internal spacing, may be performed in buildings larger in size and differently constructed from those used for heavier fillings. A heavy protective roof might be acceptable here as the explosion of one shell is highly unlikely to bring it down.

Buildings of the Hereford type are quite suitable, but there is always a danger of their being adapted, as in this war, to use on heavier fillings, which is wrong in principle. In any case mounding between H.E. buildings is always desirable, and internal shields and traverses are necessary. Fuzing and explodering should be shielded from other work. Roofs should be so constructed that an explosion in a cubicle will not bring the whole roof down.

(iii) For Propellants spacing need only take care of fire risks, and although difficult to estimate, about 90-ft. for brick buildings seems satisfactory. (For cutting propellants e.g. cutting cordite, the effect of a fire on those in the building is so instantaneous that the number of operatives must be kept down, i.e. buildings should be small or compartmented).

(iv) For Ammunition assembly there is little risk of a mass explosion and similar spacing to (iii) is acceptable.

(v) For Smoke filling of shell as at present, large buildings are acceptable, but escape should be easy, and long narrow shops with plenty of doors are recommended, as smoke will quickly

render visibility nil and make exit difficult.

(vi) For fuze filling compartmented buildings, separating the more hazardous operations from the less, as at present, are satisfactory.

(vii) For Detonator filling somewhat similarly compartmented buildings, of any convenient size, preferably capable of containing the whole job, from start of filling to packing for issue, are possible and even desirable. Suitable internal compartments and shields would be arranged and long units of this type are recommended.

It is proved by long experience that detonating compositions are so extremely local in their effect, and the quantities normally handled so easily containable, that there is no risk of any effect on adjacent buildings. It would be possible to build such units in pairs separated only by a fire wall.

(viii) Preparation of Initiatory Explosives, such as Fulminate of Mercury, Lead Azide, styphnate etc. should be planned as now.

(ix) All Expense Magazines to be mounded and suitably spaced.

(x) Pyrotechnic Work. This type of work involves special risks and needs careful planning. Recent experience shows that many pyrotechnic compositions are extremely violent, rising to detonative force in some cases when quantities exceed 10-lbs. or so. Further where they burn only, the heat generated is so great that, as with propellants, it gives practically no time for operatives to escape and causes many fatal casualties. Much depends upon the quantities to be handled and the type of work. Small buildings or separate compartments are preferable, spaced to prevent spread of fire.

Tracer work has generally been found to be reasonably safe as now performed, with individual shields between processes in fairly large shops, but for many of the larger pyrotechnic stores smaller shops and stronger shielding is essential.

Full account should be taken of the experience so far gained and the accident reports available in planning layout of a factory, and of each shop for this type of work.

(xi) Very large Bomb filling has been performed either in transit buildings adapted to the work, or in special units such as the "Heavy Bomb Units" at Glascoed and Elstow.

In both cases considerable risks have had to be taken as our factories were not planned for bombs of larger size than 2,000-lbs. Some plant on the lines of the Heavy Bomb Unit at Glascoed or the Tallboy layout at Risley is desirable, and a combination of the two will no doubt be achieved. The objection to adaptations is that the explosives limits have necessarily far exceeded those for which the buildings were designed, and to the Heavy Bomb Unit that it cannot, as built, be adequately mounded.

By lowering the bombs into a pit, as at Risley, and by keeping the bulk explosive in the incorporators below mound top level (probably necessitating elevating gear to pour it into the bombs) it may be possible to get a reasonably safe layout. A number of such units would require considerable space of course, but for future mass production this should be procurable.

Processes

The various aspects of future process safety within workshops, are too numerous to describe fully. If the general principles already described are followed, however, and the sources of information available are used, it should be possible to plan any process for reasonably safe production. It is again emphasized that the most important steps towards process safety, once the factory is built, should be taken in determining shop layouts, quantities, guards necessary and man-limits before a job is started or machinery etc. is installed. Training of operatives should then be put in hand.

Safety Distances

It is felt that our limited experience of accidents involving large quantities of explosives does not allow us to confirm or criticise present safety distances as laid down in the Magazine Regulations but so far as it does go the indication is that the distances are at least adequate.

The Explosive Storage and Transport Committee are understood to be reviewing the tables and it is hoped that some reduction in distance may result with consequent economy in future planning.

Lesser Explosions

With regard to lesser risks within workshops, while for well known types of small work it is usually possible so to arrange conditions as to be "on the right side", it is desirable to have information as to the exact strength of shield or wall and exact minimum distances etc. required to isolate a given explosion on new types of stores or new methods of filling, as they arise.

The effects of given quantities of explosives, of differing types and under differing conditions of confinement, is but incompletely known. As examples, the explosion of several Fuze Mine Contact, involving a total of some 4.1/2-lbs. of C.E. did serious structural damage to the building at Kirkby, (See report No. F.255), which was unexpected, as the degree of confinement was low. 100-lbs. of explosive in 8-lb. bombs in a cluster, again at Kirkby, did very serious structural damage to the building in which contained, and subsequent experiments at Millersford showed that it was very difficult to contain such an explosion (see report by C.S.A.R.). We have now put such work into steel cubicles at Chorley but are by no means sure that they are adequate.

An experiment with a 17-lb. H.E. shell, at Thorp Arch in connection with breaking down of ammunition, showed that the explosion of one such almost completely demolished a 10 x 10 building with 13-in. brick walls, though we had estimated that a 9-in. wall would contain it. In this case there was a heavy concrete roof which increased confinement but we do not know what is necessary to protect operators against such an explosion.

Further work therefore on the lines of testing run of work, to determine the protection necessary, seems a highly desirable line of research on future factory safety.

Incentive Bonus (Notes on Safety)

Efforts of Incentive Bonus Schemes.

In 1941 a committee was appointed to consider payment by results in Royal Filling Factories. This had been the rule at Woolwich on all but H.E. work, preparation of initiatory explosives, and some other highly sensitive compositions, but we had reverted to Time Work in all New Royal Filling Factories. The Committee decided that the great bulk of the work could be now paid on a Payment by Results basis and subsequent discussions led to some modifications which increased the number of types of job to be so paid. Such jobs as were not suitable for Payment by Results, on account of the care and skill necessary to avoid accidents, were specially dealt with.

The results have fully justified the decision as the accident rates quoted elsewhere will confirm.

Incentive Bonus

This is the subject of a separate monograph. (No. 15513).

Training of Operatives

This has been referred to briefly on page 8, paragraph 10. It has a considerable bearing upon safety in working, and its initiation was due in some degree to the frequency of accidents with inexperienced operatives. Training in Royal Filling Factories is the subject of a separate monograph. (No. 15512).

SECTION 6

SUMMARY

The safety of workers and property in the Royal Filling Factories has been the special care of the Department throughout the War. It is achieved, firstly, by proper planning of the factories with due regard to their purpose, so far as this can be done in an industry where development of new stores is rapid. Certain broad principles are applicable and are herein described. Generally they have met our requirements, though the huge increase in size of bombs was not foreseen and work has had to proceed on such stores with explosives limits far in excess of those for which we had planned.

Secondly, proper attention to cleanliness, layout, limits of quantities, tools, training of workers etc. is essential and this has kept accidents down to a reasonable level and thereby rendered such excess over proper limits as has been unavoidable, less serious.

Thirdly, Fire Fighting appliances and drill are provided for on an ample scale and have proved efficient in preventing spread of fire or explosion.

Continuance of safety precautions on the present lines is desirable, with such improvements as experience may from time to time dictate. Criticism of our methods of planning were on one occasion made by a Parliamentary Select Committee, but our explanations to the Committee were accepted. Results justify the methods, but, as stated herein, experience indicates some lines of relaxation which might well be adopted. The full co-operation of all concerned in factory management, and of the workers, has achieved the satisfactory results indicated.

BIBLIOGRAPHY

	Available with
Safety Certificates	D.O.F.(F) (or from C.S.A.R.)
Accident Reports	D.O.F.(F)
Returns of Explosives Limits	D.O.F.(F)
Reports on cleaning up sites	D.O.F.(F)
Danger Building Rules	D.O.F.(F)
Instructions for preparing Superintendents' Safety Orders	D.O.F.(F)
Filling Factory Instructional Memos	D.O.F.(F)
Minutes of Burning Ground Committee	D.O.F.(F)
Booklet of ensuring "Freedom from Explosives"	D.O.F.(F)
Instructional Memos on "Freedom from Explosives"	D.O.F.(F)
Development of Non-sparking needles for Sewing Cordite Bags - 287/Met/36	W.D.(D)2

INDEX

Orders by the Chief Fire Master of the Royal Laboratory 1 of March 1799

The People who may be employed in Diving of Composition of all Descriptions are desired to keep their Bodyes in an Erect Position so as to be Clear of the Mould & which will in a great Measure Preserve them from the Fatal Consequances of Stricken upon Accident to

Not to exceed the Undermentioned Quantity of Composition in each Box when Diving

Each Fuze Takes	oz	Dr
13 Inch Fuze	2	8
10 Do Do	1	8
8 Do Do	1	0
5½ Do Do	0	8
4⅖ Do Do	0	6
Hand Do Do	0	3
Portfire	3	8
Rocket of 1 ℔	6	4

Boxes	℔ oz	℔ oz
From	1 .. 0	to 1 .. 8
Do	0 .. 12	to 1 .. 0
Do	0 .. 8	to 0 .. 12
Do	0 .. 6	to 0 .. 8
Do	0 .. 4	to 0 .. 6
Do	0 .. 3	to 0 .. 4
Do	1 .. 0	to 2 .. 0
Do	1 .. 8	to 2 .. 0

APPENDIX B

EXPLOSIVES IN THEIR RELATION TO FIRE RISKS

1. GUNPOWDER. This explosive will explode immediately fire reaches it.

In workshops it should be present only in small quantities divided up between several operatives. Explosion will probably start with one of these small quantities and may, and probably will, start a small fire which, if not mastered at once with the buckets and extinguishers, will spread very rapidly. Efforts must be made at once to drown the gunpowder in the expense receptacles. If, as is sometimes the case owing to there being no expense store, there should be an open barrel of gunpowder in the shop, containing anything up to 100-lbs., the first step should be, if possible, to drown or remove this. If this cannot be done and the fire has obtained the mastery and is approaching the barrel all persons must withdraw to a safe distance until the gunpowder has exploded, and efforts must be made by wetting the roofs of neighbouring buildings, removing or drowning explosive, etc. to reduce the danger of the spread of fire and explosion. For the definition of "Safe Distance" see below.

Where workshops are supplied with their gunpowder from neighbouring expense magazines, often very close to the workshops themselves, the removal of the explosive from these Magazines, or its being wetted, should be dealt with at the earliest possible moment.

It should be distinctly understood that wetting of the gunpowder means that water is poured into the barrel and the contents drowned. Wetting the outside of the barrel is quite useless. If the fire reaches an expense magazine and gets a hold on it, all persons must be withdrawn to safety at once. It is needless to add that this last applies with even greater force to bulk storage magazines of gunpowder.

Where gunpowder is present, even in considerable quantities, but enclosed in small articles such as percussion primers, tubes and fuzes, explosion en masse need not be feared; and considerable boldness in dealing with the fire admissible, and the risk of injury by the fragments due to the bursting of individual articles may be accepted quite justifiably. But the distinction between such articles when closed and before closing must be carefully noted. A number of trays of filled primers but without discs or with discs not burred over might produce a severe explosion which would throw whole primers about with great violence. As stated hereafter in connection with filled shell and detonating fuzes and gaines, if there is danger of large numbers of these articles being heated up simultaneously to ignition point, all persons must be withdrawn to safety. As to gunpowder in shells, see filled shell below.

2. WET FULMINATE OF MERCURY IN BULK AND WET GUNCOTTON. These explosives, when thoroughly wet are, so far as all experience has gone, impossible to explode en masse. A fire in a store of them, therefore, should be fought as long as there is no clear indication that the fire has gained such mastery that the barrels or cases are leaking or damaged and there is a danger of the fulminate of guncotton becoming dry.

DRY FULMINATE OF MERCURY IN BULK, DRY GUNCOTTON, AND ALL DETONATING COMPOSITIONS. These will explode immediately the fire reaches them. A fire, where these explosives in bulk are involved,

should be treated similarly to a fire in a magazine or expense store of gunpowder.

DRY FULMINATE OF MERCURY AND DETONATING COMPOSITIONS ENCLOSED IN DETONATORS. These should be treated similarly to the explosives in bulk if in drying buildings or varnishing shops.

3. COMPOSITION EXPLODING (C.E.) AND TETRYL. This explosive in small quantity, unconfined, and spread in thin layers will, so far as experience has gone, burn and not explode; and a fire in a workshop, where it should only be present in small quantities, can be treated with considerable boldness. When however, there are gaines or fuzes, filled with it, present in the workshop affected or any pellets in pressing or wrapping shop and the fire has gained mastery with the risk of the filled articles being heated up to explosion point, all persons should be withdrawn. See Filled Fuzes and Gaines below. C.E. Pellet explosions are extremely violent.

Composition Exploding (C.E.) and Tetryl in bulk in a magazine. This should be treated as gunpowder in similar conditions, but is even more devasting, though more local.

4. TRINITROTOLUENE IN BULK IN MAGAZINES OR EXPENSE STORES. The behaviour of this explosive when burnt unconfined, or with comparatively slight confinement given by wooden boxes has been very capricious. It has sometimes burnt away harmlessly in large quantities, but on other occasions it has exploded. Considerable experience has, however, been obtained of its behaviour when burnt unconfined up to quantities of 100-lb; and it is also quite safe to say that, unlike gunpowder it will usually not explode immediately fire reaches it. Great boldness therefore is admissible in the endeavour to put out a fire in a T.N.T. Magazine even when some of the T.N.T. has actually ignited, as at first it burns sluggishly. When however, any larger amount of it has become ignited and water even in considerable volume is obviously incapable of preventing the increase of the fire all persons must be withdrawn to a safe distance. In dealing with T.N.T. in Magazines every effort should be made to get water in large volume on to the fire. Many magazines are provided with drenchers, but everything should be done to supplement the water delivered by these.

The importance of stacking the packages in Magazines and Stores so that there is a passage way all round the stacks which will enable water to be directed on them all round, cannot be over estimated. Underground or semi-buried magazines are particularly difficult to deal with.

T.N.T. IN WORKSHOPS. It is, or should be, the universal practice to remove the cotton bags, in which this explosive is contained inside the usual boxes, immediately it is taken from the boxes for use, and to store it temporarily in metal bins. This precaution is of great importance as experience has shown that cotton fabric impregnated with T.N.T. ignites far more readily than T.N.T. alone.

If a fire starts in a building where T.N.T. is being put into bins the treatment of it will obviously be of a similar character to that suggested for magazines and expense stores, but it should be very simple to drown the contents of open bins, while the metal of the bins which are closed will not assist the spread of the fire as the wooden boxes will.

T.N.T. IN MELTING PANS. There has been little or no experience of ignition of this explosive in the ordinary hooded pans which are not hermetically sealed; but, from the behaviour of small quantities ignited when molten, and judging by the known results with picric (see below) in somewhat similar circumstances, immediate explosion need

not be feared and a fire should be fought with boldness at the beginning and after 5 minutes or so treat as gunpowder. Drenchers over pans are highly desirable.

5. PICRIC ACID. While quite recent experience has tended to show that this explosive will explode when comparatively small quantities (about 2,000-lb.) quite unconfined have been set on fire, and the opinion that this explosive could be ranked at least with T.N.T. in the likelihood of its burning in comparatively large quantities without explosion, has had to be altered, there is no question that when first set on fire it behaves very similarly to T.N.T. though it burns somewhat more rapidly. Consequently the remarks as to T.N.T. above apply to Picric Acid also.

PICRIC ACID IN MELTING CANS. There has been sufficient experience of ignition of this explosive, when being melted by insertion of the cans or other vessels containing it, into hot oil heated by gas or electrically, to enable it to be stated with considerable certainty that, in the quantities usually present in such circumstances, explosion need not be feared; and a fire therefore in these conditions can be fought with boldness. The ordinary melting tanks for cans do not lend themselves readily to fitting with drenchers, but there is no reason why they should not be fitted over pans. It must be remembered, when dealing with a fire in a melting tank in which oil is the medium through which the heat is imparted to the cans containing the pioric acid, that the oil is, when properly heated up, at a high temperature, (about 330°F) and the first impact of water will lead to a fairly violent generation of steam which may throw hot oil about the building.

6. AMATOL. 80/20 Amatol in bins, incorporating machines, waste amatol in dumps, and "Hot Mix" 80/20 Amatol when removed from the mixers and prior to insertion in shell, should be treated as T.N.T.

The behaviour of "hot mix" 80/20 amatol in large quantity in the mixers if ignited is unknown; but all such mixers should be provided with drenchers, capable, if a fire only is the result of ignition, of putting out the fire by flooding. In the case of the poured filling of 40/60, 50/50, and 70/30 Amatol an ignition has occurred of the contents of a mixer in which, owing to the steam heating having been cut off, the contents had solidified. The end of the mixer was being removed, using a brass chisel, when the contents took fire. The Fire was extinguished in a few minutes by turning a stream of water down through the Ammonium Nitrate re-heater and by taking a small end piece off the mixer and turning the water through that. That there was a serious fire was obvious from the volumes of black smoke which were pouring up the pipes to the Ammonium Nitrate re-heater and T.N.T. melting pan.

The pipes which respectively carry the T.N.T. from the melting pan, and the Ammonium Nitrate from the Ammonium Nitrate re-heater are obviously ready methods of flooding the mixer in the event of its catching fire. The only doubtful point is whether if as would ordinarily be the case, the Amatol were in a molten condition and at a temperature of 100°C. or a little over, the rush of steam due to the contact of the cold water coupled with that of the heated gases, due to the fire, might seriously impede the entry of water, and so render the attempt to put out the fire unjustifiably risky; for there appears to be an extreme probability if not an absolute certainty, of a fire in these conditions of confinement in a comparatively strong cylinder with only small vents, leading very rapidly to explosion.

It cannot be said that the occurrence described above has entirely removed the doubt, as besides the amatol having solidified there were additional vents for the escape of gas pressure; but it

seems probable that, with a good water pressure in the fire mains and the insertion of the hose nozzles into the communicating pipe, water in large quantity could be forced into the mixer. The question, however, of providing for the easy insertion of hose nozzles into the communicating pipes will have to be carefully considered. With the pipe for Ammonium Nitrate (except for the grating which sometimes covers its entrance and should be readily removable if the bars or holes in it are too small to allow the entrance of a hose nozzle) there should not be much difficulty, but it may be otherwise with the T.N.T. pipe.

Mixers of this olass should be fitted with drenching pipes similarly to the mixers used for "hot mix" 80/20 Amatol and minol mixers.

Seeing, however, the very serious possibilities arising, the importanoe of dealing at onoe with any fires which may, if unchecked, get down into the mixer, and the desirability of installing drenchers, not only over the melting pans (already referred to) but over the Ammonium Nitrate re-heater also, are emphasised.

7. GUNPOWDER IN SHELL. In ordinary course gunpowder will mainly be used in Shrapnel Shell. If the fire occurs in a filled shell store where all the shell are plugged or fuzed, the outbreak will be dealt with as in the case of H.E. filled and plugged shell.

The treatment of finished Q.F. Ammunition where the presenoe of propellant oharges and wooden boxes complicate matters, is dealt with separately.

There is happily no actual experience of the effects of a fire (however originated) in a workshop where shrapnel shell are being filled and it is only possible therefore to attempt to foreoast what would happen in certain events.

Assuming that the fire originates with the explosion of a shell, it is probable that any communication of the flash to other open filled shell close by will take place at onoe. If this explosion leads to a fire it will be dealt with exactly as already detailed in (1), every effort being made to drown all open filled shell and expense supplies of gunpowder. If the fire gains the mastery and there are present in the building filled and plugged or fuzed shell which cannot be removed, all persons must be withdrawn to a safe idstance as in the oase of H.E. shell in filled shell Stores.

8. AMATOL IN SHELL. Experienoe has shown that amatol in unplugged shell is not at all easy to ignite. There have been many explosions of shell in press-houses with shell actually alongside in the press, and bogies and trucks of filled and unplugged shell standing close by the press, and in no case has the concussion due to, or flash of, the exploding shell caused the explosion of others. The fact that amatol spread out in the open is very difficult to ignite is a commonplace, and extensive experiments have shown that amatol dust mixed with air even in quantities far exceeding those which oould be met with in ordinary work will not, even on powerful ignition, give rise to a so called dust explosion. This it may be added is also the case with T.N.T. Further the explosion of a 12-inch shell filled 50/50 has not communicated either fire or explosion to open and filled shell standing alongside it. Experience has also tended to show that a shell filled with amatol if actually ignited by a flame will often burn out without explosion though occasionally explosion has resulted. On the other hand tremendous explosions have been oaused, as would naturally be expected, when filled shell have been heated up to explosion point (about 440°F.) owing to their being surrounded with burning material

resulting from the conflagration of the buildings in which they were stored.

It is therefore quite justifiable to fight a fire, however caused, where shell are being filled with amatol until the fire has gained such a mastery that filled shell are being exposed continuously to fierce flame close to them. Of course everything should be done to drown the contents of all filled shell and all exposed amatol at the earliest possible moment.

9. PICRIC ACID IN SHELL. There is no experience of fires in workshops when filling this explosive into shell. It is known to be more sensitive to shock but has a slightly higher ignition point than Amatol. The experience also of the effect of the blast of hot gas, due to the explosion of a shell, in setting other filled and unplugged shell on fire has been too limited to base definite opinion upon it, but, as has been pointed out above under (5), it is not easy to ignite. It is however, known that the explosion of a shell filled with picric acid will cause the explosion or detonation of other plugged shell similarly filled quite close to it, and with large shell (12 inch and upwards) at distances up to 10 feet. It is also certain that, if heated up in a filled shell to ignition point (470°F), it will detonate or explode with extreme violence.

In spite of there being no direct evidence that a filled and unplugged shell may burn without explosion if ignited by a flame, it will be justifiable to treat a fire in a shop in which shell are being filled with picric acid similarly to one in a shop where shell are being filled with Amatol.

10. STORES OR MAGAZINES OF FILLED H.E. SHELL (UNBOXED). The Remarks above under (7) and (8) may be taken as covering these stores except that, since all the shell are, or should be, plugged, and no open explosive is present, the only danger to be apprehended is the heating up of the shell by their being exposed continuously to the flames. Until this actually happens and the fire has obviously obtained complete mastery, efforts to extinguish it must continue.

11. STORES OF Q.F. AMMUNITION WHETHER CONTAINING H.E. OR SHRAPNEL SHELL. Experience has shown that the wood boxes in which the ammunition is packed, coupled with the presence of propellant charges, tend to make a fire spread with very great rapidity, while the presence of fulminate detonators, whether in the fuzes or gaines, tends, if propagation of explosion takes place owing to the fuze being heated up or struck, to a high grade of detonation of the shell. It follows therefore that nowhere is the promptest, boldest, and most efficient fighting of a fire more necessary than in the case of a ½ Q.F. Ammunition Store, in order to attempt to extinguish the fire at the outset; and, until it has attained such proportions that further efforts are obviously useless, the fact that some explosions may have taken place should not necessarily lead to determined attempts to extinguish the fire being discontinued. It is fully recognised that in continuance of effort risks of loss of life will be run; but on the other hand it is also almost certain that the premature abandonment of a fire in these stores, especially if the store be the issue store of a large factory, where immense numbers of H.E. rounds are often present, may have an absolutely disastrous effect on the rest of the factory.

The importance of stacking as described in the conoluding paragraph of (4) above is again emphasised.

12. STORES CONTAINING ASSEMBLED FUZES AND GAINES AND DETONATING FUZES SUCH AS No. 106 OR No. 44. The rate of spread of a fire in a store of this character will be affected according as the articles are packed in boxes or are merely stored on racks unpacked. Experience has shown that the explosion of a few of these articles will not lead to explosion en masse. But, though there has been no instance of its occurring, there can be no question that if a large number of these articles are heated simultaneously up to explosion point a formidable explosion might occur. The risks to be taken in fighting a fire to the last would be similar to, but much smaller than, those described for Q.F. Ammunition Stores.

13. AMMONAL, FUMYL, SMOKE COMPOSITIONS (other than phosphorous). These are in most cases similar in character to Amatol and may be treated as such.

14. PERCHLORATE EXPLOSIVES. While some of these explosives are sluggish in ignition, and might burn in fair quantity even when confined in wooden boxes, before explosion, others, notably R.D. 30 and R.D. 30B, and practically all pyrotechnics in large quantities will probably explode at once. It will be safest therefore to place all these explosives in the same category as gunpowder.

15. CORDITE, CORDITE R.D.B., BALLISTITE, AND NOTRO COTTON PROPELLANTS. So far as experience has gone the only fear with these is a fire giving off enormous heat but without explosion. The possible effects of this great heat must not be ignored as firemen very close to a Magazine containing large quantities of it might be very badly, if not fatally, burnt before they could escape. As an instance of the heat given off, the following, which actually occurred, is given. 50 tons of Nitro cotton burnt away in a Magazine in the United States. Curtains in a building about 170 yards from the fire were badly scorched. While therefore a fire in a Magazine or store should be boldly dealt with as in the case of T.N.T. even after a little of the explosive in its packages may actually have caught fire, all persons must be withdrawn immediately the fire has obtained the mastery, as when once this has happened the spread of the fire will be very rapid. Although no explosion will occur the vertical rush of the flames will be very violent and will carry up with it much burning explosive and other debris to a considerable height. With a strong wind this will certainly endanger other buildings to leeward and these must be well watered and carefully watched for new fires. It will normally only be possible to approach such a fire from windward.

16. MINES & BOMBS. These will be classified with shells filled with the same explosives, except that modern thin-walled bombs will be much more liable to explode.

17. SHELLS AND BOMBS CONTAINING POISONOUS GASES AND LIQUIDS. So far as the treatment of a fire goes in relation to explosives, these will be classified with shell filled with the same explosives, but the fact that poisonous gases will be present, if an explosion has preceded the fire or occurs during its progress, is a very serious added complication; and provision of gas masks and precise instructions to the firemen as to what risks may, and what may not, be run will be essential.

18. Many changes have been made during the progress of the war in the explosives in use and there is no reason to suppose that finality has been reached in this respect, nor does this statement cover all the explosives at present in use for warlike stores, which might be used hereafter in the National Filling Factories. No doubt Managements, when called upon to use explosives new to them, will, if uncertain as to their classification, broadly speaking, treat them as similar in their action to Gunpowder or T.N.T. and obtain an authoritive statement as to

their probable behaviour and pecularities from D.F.F.(P) at the earliest possible moment.

19. RECTIFICATION AND REPAIR OF EXPLOSIVE STORES, AND THE EXAMINATION AND BREAKING UP OF SUCH STORES RETURNED AFTER ISSUE. There is one important point which deserves emphasis, which, though it has nothing to do with the fighting of fires, has much to do with the prevention of fires occurring at all. It must be realized that the most likely causes of accident leading to fires are the absence of explicit instructions to the workers to cover the carrying out of their work, to unsuitable methods being laid down, and to improper use of the tools necessarily present. The remedies for the first two, which are now uncommon, are obvious, and as to the last no effort should be spared to endeavour to arrange the work to be done so that there may be the smallest possible temptation to workers to use the tools improperly (usually owing to the incurable habit of workers to save time or labour even though they run risks against which they have been explicitly warned). Above all on no account whatever should work be done with any larger amount of explosion stores present that is absolutely essential.

These remarks apply with special force to the rectification and repair of explosive stores and to their opening up and examination for serviceability especially when they have received an unknown amount of rough usage, and with the greatest emphasis of all to the breaking up of explosive stores returned definitely as damaged or doubtful. With miscellaneous work of this kind there is in the first place considerable difficulty in laying down any explicit instructions and a tendency to omit doing so, while the nature of the work may necessitate the presence of many tools which are always liable to improper use as mentioned above. At present only rectification and repair of articles found defective during inspection before issue is common to all the National Filling Factories, and examination and breaking up of returned stores is confined to a few, but there is no certainty that the latter work may not extend bringing with it its special dangers.

20. SAFE DISTANCE TO WHICH WITHDRAWAL IS TO BE MADE WHEN SERIOUS EXPLOSION RESULTING FROM A FIRE IS EXPECTED. It is possible to decide this positively in the case of the ordinary workers by laying down that they shall leave the factory and get as far away as possible and as rapidly as possible.

In the case of those whose duty it is to fight any fires resulting from the explosion and projected burning debris, it is impossible to lay down any minimum distance which shall ensure their safety in all cases without making it so great that it would be impossible for them to return to deal promptly with fresh fires which may have resulted. It is sufficient in this connection merely to point out that fragments of shell, bombs, etc., may be expected to travel over a mile, and portions of constructional steel, when the quantity of explosive involved is large, nearly as far. The following general directions are therefore given as guides for action to secure, not absolute, but a considerable amount of safety.

Serious injury to human beings or the blowing down of walls by BLAST EFFECT ONLY need not be feared in the open.

(a) With large quantities of gunpowder or high explosive up to 25 tons at a distance of 400 yards.

(b) With small quantities of the same explosives up to 500 lbs. at a distance of 100 yards.

As, however, the occurrence of a serious explosion giving blast effect only, without some projected debris, is a practical impossibility, the immense importance of cover, in addition to distance, is discussed below.

The results of the explosion of quantities much in excess of 25 tons, whether of gunpowder or High Explosive, are not accurately known. Quantities of H.E. greatly in excess of this exist in some of the Magazines in the National Factories, but it is useless to speculate upon the probable results of their explosion. Where these Magazines or large bomb filling shops have been placed unduly close to other buildings, it is feared that, even with the traverses provided, wholesale wreckage would ensue owing to blast effect. It is the explosion of smaller quantities in workshops and expense magazines and the projected fragments of shells, etc., that in ordinary course are the more likely, and with these the protection which can be afforded by walls and buildings must be taken into account.

Experience has shown that an 18 inch wall of good brick is proof against the explosion of an 8 inch Howitzer shell within 2 feet of it and it is probable that even a 14 inch wall at 100 yds. would be proof against any but very large fragments. Most serious consideration should be given by all Managements to fixing on places of safety which would be used in various contingencies; and such places, if they do not already exist owing to the presence of suitable buildings, could be made at comparatively small expense by mounds of earth about 3 feet thick revetted with boards or corrugated sheeting.

Ministry of Munitions of War.
May 1918.

Modified as underlined in 1944.

D.F.F.(P)

SM(Y)6462(40-15.5.44)DSFF.

APPENDIX C

IMPERIAL CHEMICAL INDUSTRIES LIMITED
DYESTUFFS DIVISION

Proposed Specification for Testing Fireproofed Textile Materials

In essence, the test consists in subjecting the fabric in horizontal position to a flame produced by a specially designed burner fixed at a specified distance below the fabric. The longer dimension of the BURNED area is noted; any scorching outside this burned area shall be disregarded, but the time for which glowing continues after extinction of the gas flame shall be measured.

A minimum of three samples shall be taken from each treated batch, none of which shall fail to comply with this test.

Gas Burner:

The gas flame is produced from a slit in the top of a rectangular gas-tight metal box. The box is 6.3/4-in. long, 1-in. high, and 1.1/4-in. wide. The top contains a rectangular aperture 6.1/4-in. x 1/4-in. situated centrally. A hole 1/4-in. in diameter is drilled in the centre of the one end and a thin metal tube 3/4-in. long and 1/2-in. in diameter is soldered around it.

The top of the box, excepting for the aperture is completely covered with 1/8-in. asbestos board. Above the asbestos board are placed two straight-edged metal strips 6.1/2-in. long and 1/2-in. wide. These are situated side by side and can be moved together or apart but can be fixed to the box in a given position by four bolts, two at either end, so as to give a slit of the desired dimensions. The ends of the slit are defined by two small metal strips laid 5-in. apart across the ends of the slit.

A baffle is constructed from perforated metal sheet 2-in. long and of the width equal to the internal width of the box. The baffle is situated between the base of the box and the upper edge of the inlet end.

Gas Supply:

A hole 0.045-in. in diameter is drilled through the centre of a solid brass cylinder 9/16-in. diameter and 7/16-in. in length. 1/4-in. of the length of this brass rod is turned down to 1/2-in. diameter so that it will fit tightly into a brass cylinder 1.1/4-in. long, the sides of which are approximately 1/64-in. thick. A hole 0.166-in. in diameter is drilled into the centre of the side of this brass cylinder. This hole forms the standard air inlet. This gas leak and standard air inlet is connected between the gas supply and the gas inlet of the burner by means of rubber tubing.

Manometer:

On the supply side of the gas leak the pressure of the gas is measured during the test by means of a water manometer. In order to obtain the requisite sensitivity to ensure exact reproduction of the specified gas pressure it is necessary that the open limb of the manometer shall be constructed of capillary tubing and shall be inclined at an angle of approximately 15° to the horizontal.

A suitable manometer may be constructed according to the dimensions given, from which the open limb may be calibrated to read directly in mms. hydrostatic pressure.

Test Procedure:

Each specimen under test shall be held in a circular frame of the embroidery frame type, of 6-in. diameter. A suitable frame consists of two concentric metal hoops made from steel strips 1/2-in. wide and 1/16-in. thick. This frame is clamped horizontally so that the face side of the fabric is facing downwards and the metal sides of the hoop project upwards, i.e. the metal sides of the hoop do not project downwards and thus delay free access of air to the lower side (face side) of the fabric. The whole is mounted in a draught-free enclosure, consisting of a three-sided wooden box with a sliding glass front. Access of air for combustion shall not be prevented and the apparatus shall be such that the progress of the test can be observed.

The slit in the gas burner is adjusted by means of a fine template to be 0.070-in. wide at one end and 0.035-in. wide at the other end. The wider end of the slit is remote from the gas inlet. The gas burner is supported 3/4-in. immediately below a diameter of the test specimen.

The gas pressure is adjusted to read 1.5-cm. vertical height of water, on the water manometer. A small source of heat is applied to the gas burner (e.g. a small gas jet or an electrically heated filament) and the standard gas flame is allowed to burn for 15 seconds. The gas supply is then cut off and the pattern is observed for continuation of combustion. When all combustion has ceased the pattern is removed and the longer dimension of the inner burned area is measured.

This length shall not exceed "x" inches, and the time for which glowing is observed after the gas flame is extinguished shall not exceed "y" seconds.

Since "Lasting Cloth" has been proved by past experience to give adequate protection to personnel involved in fires it has been taken as a Standard and the "x" inches and "y" seconds for materials under test shall substantially conform to the comparable figures for accepted "Lasting Cloth."

APPENDIX D

EXPLOSIVES	May be used in contact with:- (COMPATIBLE)	Contact should be avoided with:- (Not COMPATIBLE)	Preferred for Tools Various
Ammonal	A B K M V W X Y	C D E F S M L O U	A K V W
Amatol	A B K M V W X Y	C D E F G H L O U	A K V W
Ammon. Nitrate	A B K M V W X Y	C D E F S H L O U	A K V W
Amatex	A B K M V W X Y	C D E F S M L O U	A K V W
Baratol	A B K M V W X Y	C D E F G M L O U	A K V W
C.E.	A B C D E F H I K L M N P Q U V W X Y	J * (1) *	A D E K L U V W
C.E./Aluminium	A B C D E F H I K L M N P Q U V W X Y		A D E K L U V W
Minol	A B K M V W X Y	C D E F G J M L O U	A K V W
Nobels 808	A B E K L U		
PETN/T.N.T.	A B C D E F K L M P T U V W X		A E K L U
PETN/TNT/DESEN.	A B C D E F K L M P T U V W X		A E K L U
Picric Acid	A L M U V X Y	N (4)	A L U (4)
Plastic Explosive (P.E.No.122)	B D C D E H I L M P Q T V W X Y	(2) A F K (2)	
R.D.X.	B C D E H L M P Q T V W X Y	(2) A F K (2)	
R.D.X./B.W.X.	2A B C D E H I L M P Q T V W X Y	F	
R.D.X./T.N.T.	2A B C D E H K L M P Q T V W X Y	F	
Shellite	A L M U V X Y	N (4)	A L U (4)
T.N.T.	A B C D E F G H I K L M P Q T U V W Y	-	A D E K L U V W
T.N.T./B.W.X.	A B C D E F G H I K L M P Q T U V W Y	-	A D E K L U V W
T.N.T. Aluminium	A B C D E F G H I K L M P Q T U V W Y	-	A D E K L U V W
Torpex	A B C D E H K L M P Q T V W X Y	F	A E K L U W
Fulminate of Mercury	C D E F L M P T U V W X Y	A B K	Copper and alloys are attacked by F/M but without danger.
Lead Azids	A K Q T W V Y	Copper and alloys of copper (3)	
LDNR & RD1305	(4)	(3)	(1)*
Lead Styphnate			(2)
Pot. Chlorate			
Nitrocellulose			
Nitro Glycerine			
Gunpowder			
R.D.202			

(1) *Chromium plating is not recommended due to the risk of flaking.

(2) R.D.X. due to the presence of occluded nitric acid, should be kept clear of aluminium and copper RDX/BWX and RDX/TNT (except certain lots of marked high acid content) are not likely to have this disadvantage and may be used with aluminium.

(3) Lead azide when moist, in contact with copper alloys, may form copper azide - of uncontrolled sensitivity. Copper and its alloys are satisfactory for contact in all stages after manufacture if kept dry.

(4) All metals used with Picric acid should be of known lead free specification.

KEY TO ABBREVIATIONS

ALUMINIUM	=	A
AL/BRONZE	=	B
BERYLIUM/COPPER	=	C
BRASS	=	D
BRONZE	=	E
COPPER	=	F
COPPER, TINNED	=	G
CUNIAL BRONZE	=	H
CUPRO-NICKEL (BS.734)	=	I
CHROMIUM (PLATING)	=	J
DURALUMIN	=	K
GUNMETAL (BS 382&3 & 88/8/4)	=	L
IRON (WROUGHT)	=	M
LEAD	=	N
MERCURY	=	O
MONEL K	=	P
MAZAKS	=	Q
MAGNESIUM	=	R
MANGANESE	=	S
NICKEL	=	T
PHOSPHOR BRONZE	=	U
STEEL	=	V
STAINLESS STEEL	=	W
TIN	=	X
ZINC	=	Y

APPENDIX E

Filling Factory Instructional Memo No. 225

Superintendent,
R.O.F. .....

PROCEDURE IN CONNECTION WITH ACCIDENTS DUE TO EXPLOSION OR FIRE

This is a codifying instruction and supersedes previous instructions on the above matter.

REPORTING OF ACCIDENTS

On the occasion of any accident in, or connected with, a Filling Factory, where there are any casualties, any loss of production, or any damage to machinery, information must be communicated immediately to D.G.F.F. by telephone (Gerrard 6933, Extension 1022).

During Sunday, information should be communicated to the Officer on duty in the D.G.F.F. Department, whose number is notified to the telephone operator.

During the night, or when, for any other purpose, the office is closed, the accident should be reported to the DUTY OFFICER in the Ministry (Telephone number available to the telephone operator).

The following information is required:-

(i) Time and place of the accident.

(ii) Work being performed at the time of the accident.

(iii) Any casualties:

In the case of a fatality, it is essential that the following information is given:-

(a) Name and sex of the operative.

(b) Married or single.

(c) Grading.

(d) Next of Kin.

(e) Relationship of next of Kin.

(f) Address of next of Kin.

(g) Whether next of Kin has been informed.

(iv) Damage to buildings or machinery.

(v) Time estimated for bringing into action again.

(vi) Effect on Production.

(vii) Any other point of interest.

As much as possible should be communicated by telephone, and later confirmed and amplified by teleprinter.

Minor accidents are regarded as reportable if they involve injury or shock which will result in the absence of the operator or operators during the succeeding shift at which he or she would normally be present, or which cause appreciable damage to buildings or plant.

The I.D.B. and the Factory Security Officer should also be informed of all accidents.

COURT OF ENQUIRY

D.G.F.F. will decide the nature of the Enquiry to be held, viz., (i) by H.M. Inspector of Explosives, Home Office, (ii) by M.A./C.S.O.F. (or representative), or (iii) by local enquiry. No delay beyond that necessary for the President to attend should ensue before holding the enquiry. It is essential that steps be taken to ensure that the scene of the accident is left undisturbed, so that all evidence is available to the members of the court.

(i) Serious Accidents involving fatalities or serious material damage and which in the opinion of D.G.F.F. are of sufficient importance or obscurity to warrant investigation by Home Office.

D.G.F.F. will decide upon the composition of the court, and time and place of meeting, and will notify Departments required to send representatives.

It is desirable to limit so far as practicable the numbers of the court, and its membership will normally be:-

President (His Majesty's Inspector of Explosives).
D.G.F.F. or his representative.
Superintendent, or Assistant Superintendent of the Factory.
An Officer (or Officers) from Headquarters with knowledge of safety and production matters.
A representative of the Inspection Department principally interested and of D.E.R.
M.A. to C.S.O.F., or his representative.
A workers' representative - preferably not from the Section or Group concerned.

Secretary - from the executive staff of the factory.

The President will arrange for the attendance of such other individuals, who will not be members of the Court, as, in his opinion, may be necessary in pursuing the enquiry.

If there is any suspicion of sabotage, the Factory Security Officer should be asked to make a statement to the President of the Court of Enquiry and in cases of strong suspicion be co-opted as a member of the court.

(ii) Serious Accidents whether or not involving fatalities in which the cause is not so obscure and which in the opinion of D.G.F.F. do not call for an enquiry by Home Office.

M.A. to C.S.O.F. will be informed and asked either to preside or to arrange for his Deputy to preside. The Superintendent will arrange to call the court, in consultation with the President, and its composition, apart from the Presidency (which covers, of course, the representation of M.A. to C.S.O.F.) will correspond with that laid down under (i) above. Superintendent should communicate with D.E.R., Halstead Place, as regards the

C.S.A.R. representative, and with the appropriate local Senior Officer of the Inspection Department as regards the representative of that Department.

(iii) Lesser Reportable Accidents, which in the opinion of D.G.F.F require only a local enquiry.

The Superintendent when so informed will arrange the enquiry as he thinks fit. The H.Q. Investigation Officer concerned and the I.D.B. should be asked to attend.

FORM OF REPORT OF ENQUIRY

In order to avoid possible embarrassment in dealing with questions of compensation, claims etc., it is necessary that the Report of the Court should be prepared in two parts: (a) what is factual or deduction from fact, and (b) what is based on surmise or opinion. The Report should, therefore, after setting out the membership of the Court, include the date, time and place of the accident, the particular work involved, a list of casualties, a statement of what was found on examining the scene of the accident and other relevant facts that transpired, and conclusions as to the causes of the accident. A memorandum of evidence taken from factory witnesses should form an Appendix. The opinions and recommendations should be set forth in a separate document as also any expert evidence leading up to them.

CIRCULATION OF ACCIDENT REPORTS

It is essential that details of the circumstances of an accident in a Filling Factory should be circulated to the other Factories as quickly as possible, and, in order to meet this requirement, it is necessary that all possible facilities and assistance should be given for the investigation, and that the following instructions should be followed:-

(i) The President of the Court of Enquiry under (ii) or (iii) above should endeavour to forward his report to D.G.F.F. within a week at the most of the enquiry. At the same time, fifteen copies should be forwarded to D.F.F.(Production), Room 617, Shell Mex House.

(ii) If it is not possible to submit the complete Report, within a week, an interim report signed by the President (fifteen copies as at (i) above) should be forwarded to D.F.F.(Production). In that event, the complete Report should follow as soon as possible. It will suffice if that is sent in duplicate to D.G.F.F. any further requirement of copies being dealt with under (v) below.

Although the Interim Report should be brief, it should give the following essential information:

(a) Membership of the Court.

(b) Circumstances of the accident including report of the examination of the scene of the explosion.

(c) Details of casualties.

(d) Deductions from the evidence that has been taken.

(e) Recommendations of an urgent nature that appear to call for preventive action.

(f) An indication of any further investigation that is being made.

(iii) The Report - or the Interim Report - will be issued to all Factories so that the Superintendents may be apprised at once of the circumstances of the accident and be able to review similar processes at their factory.

(iv) The action to be taken will be notified to Superintendents and Regions on O.F.Form No.618 issued by D.F.F./P. through D.F.F.(E). This form calls for a reply within one month. Superintendents will receive four copies, i.e. one master copy, one for "Production", one for "Services", and one for the information of I.D.B., "Services" and "Production" should collaborate to carry out any required work as quickly as possible. When no action is necessary, or where Superintendent's discretion may be exercised, the O.F. Form 618 will be marked "For information".

If an Interim Report has been issued, the full Report will accompany the O.F. Form 618.

In cases in which Headquarters are not in a position to give specific directions, H.Q.I.O. (Safety) may be sent to collaborate with the staff of a selected factory and, if appropriate, with the S.I.D.B. in order to arrive at definite conclusions, of which in due course other factories will be apprised.

(v) The full Report should be prepared so that up to seventy further copies of the letterpress can be supplied by the factory immediately if required. It is frequently unnecessary to circulate the complete appendices of an Accident Report, and request will be made by D.F.F. (Production) for the requisite number of copies, including the particular sections of the Report concerned.

ACCIDENTS IN BUILDINGS CONTROLLED BY C.I.A., I.N.O., A.I.D., etc.

The following procedure has been agreed by the Inspection Departments:-

1. C.I.A., A.I.D., and C.C.I.

(a) Where an accident occurs in a building directly controlled by C.I.A., A.I.D., or C.C.I., but inside the danger area (e.g. Proof Yard, Inspection Shop, etc.,) the procedure appropriate in the case of a similar accident in an R.O.F. building will be followed. The Local Inspecting Officer will be asked to attend and collaborate.

(b) An accident occurring on property controlled by C.I.A., or A.I.D. or C.C.I. outside the danger area (e.g. Proof Range or main C.C.I. laboratory) will be dealt with by the Inspection Department. The Superintendent will be asked to attend and collaborate.

2. C.I.N.O.

Where an accident occurs in a building directly under the control of C.I.N.O. either inside or outside the danger area, the enquiry may be held by that Department unless they prefer to leave it to the Superintendent. In any case, the Superintendent must be represented.

Serious accidents in such buildings will, as a matter of course, be reported to the Home Office by the Inspection Department concerned. Superintendents will also report such accidents to Headquarters in the normal way.

CORONERS INQUESTS

When the Coroner asks for information through his Officer, it should be freely given, except in the case of "Secret" stores. When "Secret" stores and processes are involved, Superintendents are authorised to give the Coroner, in confidence, such information as is necessary for his official use, but it should not be given to his Officers or recorded in his office files. A complete copy of the official report may be provided, if available in time, for confidential perusal by the Coroner, but if he wants a copy of such report for retention, any secret matter should be expunged from it. No copy of the report should be furnished locally to legal representatives of employees.

AGENCY AND TRADE FACTORIES.

These are licensed by the Home Office, who are responsible for limits in shops and magazines, etc. and for general safety control. Copies of all accident report forms which are applicable to their products will, however, be sent to Superintendents of Agency and Trade Factories, and they will be given the same information and assistance as R.O. Factories. Notification to D.G.F.F. of accidents in these factories is required together with findings of Courts of Enquiry.

(Sgd.) D.Morris

2.12.43. D.D.F.F./A.

FILLING FACTORY INSTRUCTIONAL MEMO No.225

AMENDMENT No. 1

Please delete the whole section headed:

"ACCIDENTS IN BUILDINGS CONTROLLED BY C.I.A., I.N.O., A.I.D.,etc."

and substitute the following:-

Accidents in Buildings operating under the control of Research Design and Inspection Departments.

The Following procedure has been agreed:

1. C.I.A., A.I.D., C.E.A.D., C.S.A.R., C.C.I.

(a) Where an accident occurs in a building controlled directly by any of the above departments and inside the danger area. (e.g. Proof Yard, Inspection Shop, etc.) the procedure appropriate in the case of a similar accident in an R.O.F. building will be followed. The Local Officer in charge will be asked to attend and collaborate.

(b) An accident occurring on property controlled by C.I.A., or A.I.D., C.E.A.D., C.S.A.R., or C.C.I. outside the danger area (e.g. Proof Range or main C.C.I. laboratory) may be dealt with by the department concerned. In this case the Superintendent will be invited to attend and collaborate.

2. C.I.N.O.

Where an accident occurs in a building directly under the control of C.I.N.O., either inside or outside the danger area, the enquiry may be held by that Department unless they prefer to leave it to the Superintendent. In any case, the Superintendent must be represented.

3. General

The Superintendent will be notified by the relevant department immediately an accident has occurred. On receiving such notification the Superintendent will report to Headquarters as indicated on Page 1. Serious accidents will as a matter of course be reported to the Home Office by the department concerned.

(Sgd.) D.Morris

8.8.44 D.F.F./A.

APPENDIX F

SAFETY COMMITTEES

Regional Directors

As mentioned at the C.E.C., the Safety Sub-Committee of the Welfare Board have laid it down that safety matters fall within the terms of reference both of Whitley Councils and of Joint Production Committees, and that our Safety Committees should fall under one or other of these headings, but preferably the latter. Moreover, all matters appertaining to safety, whether Explosives, machinery or other ordinary industrial risks, fall to be dealt with by these committees.

In reviewing the replies received from Regions and Superintendents to my former proposals about Safety Committees and Safety Officers, several points there raised need some comment, which follows:

(1) The duties of the Safety Officer and the I.D.B. need in no way clash. The Factory S.O. is the Superintendent's man, and will deal with all matters of safety (see terms of reference attached), whereas the I.D.B. is an independent Inspector, whose duty it is to see that the Superintendents Safety Orders, which mainly cover explosives safety, are carried out. He also, of course, advises, as a result of his experience.

(2) Guarding of machinery, although a matter primarily for the Factory Engineer (who in this sense is also a Safety Officer) is also a matter for the Committee and they may be able to make useful suggestions. The executive officer in this case would of course be the Factory Engineer, but the Safety Officer could no doubt assist by keeping track of jobs and act as liaison officer.

(3) In at least one factory there are two committees, a 'Safety Committee' and an 'Accident Prevention Committee.' It is difficult to see how any line can be drawn between these, as the ideal of the Safety Committee would be to prevent all accidents. One Committee would therefore seem to suffice.

(4) The technical aspect of explosives accidents need not be a bar to discussion with the workers. They have a right to knowledge on accidents generally and may be very helpful. The Chairman of the committee would in any case be able to use discretion as to how far a discussion should go, and as to what matters appear on the Agenda.

(5) The Safety Committee would have no direct relationship with any Courts of Enquiry, but would be concerned with carrying out the approved recommendations. It might be a good thing to make the S.C. the Secretary of such Courts, but this is up to the Superintendent.

(6) The Superintendents powers will in no way be diminished by the Committee. He will determine what action, if any, is to be taken on the Committees recommendations and will merely use it as an advisory body, except where he delegates authority to take action, or to follow up his decisions.

The newly proposed constitution and terms of reference of the Committee and terms of reference of S.O.s is attached for your consideration. An early reply would be welcomed.

(7) The Committee might well meet after the ordinary business of the J.P.C., those members concerned remaining and the members special to the Safety Committee joining in, but this is merely a suggestion.

(Sgd.) P.Masters

D.F.F. (Production)

15.7.1944

PROPOSED CONSTITUTION AND TERMS OF REFERENCE OF SAFETY COMMITTEES IN R.F.Fs.

1. Constitution.

(a) The Committee shall consist of representatives of the workers and members of the staff from Production, Engineering, S.L.O., S.M.O. and I.D.B. It will be a special committee of the Whitley Council or the Joint Production Committee.

(b) The Chairman shall be appointed by the Superintendent and shall be of a rank not below that of Manager.

(c) The Factory Safety Officer shall be the Secretary of the Committee.

2. Terms of Reference.

(a) The Committee shall be an advisory body, reporting to the Superintendent on all questions appertaining to safety in the factory.

(b) The committee should meet at least once per month to consider,

(i) Accidents which have occurred during the previous month at the factory.

(ii) Accident records of other factories for comparison.

(iii) Methods of prevention of accidents of all kinds either arising out of (i) or from suggestions submitted by members.

(iv) Application of the requirements of the Factory Act, Chemical Works. Regs. or any other Statutory obligations.

(v) Action taken or to be taken on approved recommendations of Courts of Enquiry, and on approved proposals of the Committee.

Proposed Terms of Reference for Factory Safety Officers.

1. He will be a member of the staff of the factory and responsible to the Superintendent, through the Assistant Superintendent (or Senior Manager if no Assistant Superintendent exists).

2. He will maintain close liaison with the Management on all matters of safety.

3. In conjunction with the Senior Labour Manager and C.F.E. of the factory, he will maintain relations with members of the Factory Inspectorate visiting the factory, and must see that the Assistant Superintendent is advised of the Factory Inspectors' recommendations, and must keep records of requirements.

4. He will maintain close liaison with I.D.B.

5. He will be secretary of the Factory Safety Committee.

6. He will attend a periodical meeting of Factory Safety Officers under the chairmanship of D.F.F.(P) or H.Q.I.O. (Safety) held to discuss and disseminate information on safety matters.

7. He will maintain records of explosives accidents occurring in the factory grouped together under types of work. He will also maintain the files of accident reports circulated from D.F.F.(Production) and be responsible for records of action and records of implementations of the Safety Committee or of Courts of Enquiry.

8. He will generally assist the Management in all matters of Factory Safety.

9. He will maintain liaison with Senior Labour Manager and the Factory Medical Officer for the purpose of compiling accident statistics returns.

NOTE: None of the duties of the Safety Officer outlined above relieve the Management of their prime responsibility for safety, but it is expected that the Safety Officer will be in a position to advise and assist the staff in keeping constant watch on safety matters.

APPENDIX G

O.F. Form 618

IMPLEMENTATION OF RECOMMENDATION OF COURTS ON ENQUIRY INTO ACCIDENTS AND OF DECISIONS OF THE COMMITTEE ON PROTECTION AGAINST STATIC ELECTRICITY CHARGES

Superintendent,
R.O.F. _____

Date

ACCIDENT REPORT No. F

_____
D.F.F. (Production)

_____
D.F.F. (E.& S)

N.B. If you are not clear on action to be taken at once, reference should be made by telephone (a) on general principle to D.F.F. (Production) or (b) on method of application in detail to D.F.F. (E. & S).

D.F.F. (Production)
Thro. D.F.F.(E)

The recommendations overleaf (have been / are being put into effect /)

..... Production

..... Services

..... Superintendent

Circulation
Regional Directors
Regional Development Officers
S.I.D.B.
Factory I.D.B.
Agency Factories for information
Regional Engineers
Headquarters Investigation Officers
Mr. A. J. Turpin

O.F. Form 618

SECRET

IMPLEMENTATION OF RECOMMENDATIONS OF COURTS OF ENQUIRY INTO ACCIDENTS AND OF DECISION OF THE COMMITTEE ON PROTECTION AGAINST STATIC ELECTRICITY CHARGES

Superintendent
R.O.F.

Date

ACCIDENT REPORT NO.F

D.F.F. Production

D.F.F. (E. & S.)

APPENDIX H

Ref: D.F.F.(E. & S.) CIRCULAR No.2

Filling Factory Instructional Memorandum (Tech.) No.123

To:- Superintendent,

_____

_____

Notes on the Design of Dust Extraction Plant for use in Process Buildings

It is frequently necessary to provide dust extraction or vacuum cleaning plants in filling shops, handling dusty or toxic materials. The safety aspect of such installations has at various times been the subject of discussion between H.M.Chief Inspector of Factories - D.F.F.(P), D.F.F. (E. & S.) and other authorities. As a result of these discussions and experience gained from a number of such installations, certain agreed principles have been arrived at, and it is thought desirable that these should be brought once more to the notice of all concerned with the design, installation and operation of such plants.

The following notes set forth these principles briefly and should be observed in all cases where explosive dusts are being handled.

1. Fans should not be placed directly in the stream of dust laden air. The only permissible exception to this rule is that in small shops where explosive risk is not great, and few people or little plant are exposed to risk, a low efficiency fan of the propeller type with wide clearances between blades and frame may be used to exhaust small quantities of dust or fume straight to atmosphere. For all larger installations the ejector type of apparatus though wasteful of power is most suitable from the safety aspect and should be used wherever possible. On no account should dust laden air be passed directly through a centrifugal fan.

2. If a motor driven propeller fan be used the electric motor should not be placed in the stream of dust laden air.

3. When an ejector set is used the exhaust may be discharged direct to atmosphere if the quantities of dust being extracted are small enough to be airborne. In cases where there is any possible objection to this practice or where the quantity of dust is considerable, filters should be placed in the system before the ejector (see paragraphs 5, 6 and 7 below).

4. The runs of ducting from extraction points to the filters or ejector should be kept as short as possible, and so designed that bends and corners are kept to a minimum. The danger from loose powder accumulating in ducting runs is a very real one and great care should be taken that cleaning holes are provided giving easy access for cleaning to all parts. Where practicable the main ducting should be run outside the building.

5. The Filters may be classified under two main headings (a) Wet Filters, (b) Dry Filters. Of these the former are definitely preferred from the safety angle, and the latter should only be

employed in the case of expensive compositions where the recovery of the material is desirable. If it is considered essential to use a dry type filter prior reference should be made to D.F.F.(P) for his approval.

6. Filters of either type should be placed outside the building. If for any reason (e.g. unduly long ducting runs) this is impracticable they may be placed inside the building only if adequately guarded against fire and explosion.

7. Wet filters may be either of the washer type employing water as the cleansing agent or of the oil impregnated honey-comb type such as the Visco or similar proprietary filters. If the washer type is used the installation should include adequate arrangements for flushing and cleansing. Due attention should be paid to the disposal of the contaminated effluents from the washers. The position of either type of filter should be such that it is readily accessible for cleaning.

8. In buildings requiring ventilation for more than one explosive separate ducting and filters may be required for each type of explosive.

The above notes are intended for general guidance in the design of future plants. Except in particularly bad cases no attempt will be made to replace existing equipment which contravenes these recommendations.

The final choice of plant to be used will of course depend on the exact circumstances of each individual case, and in case of doubt reference should be made to D.F.F. (E. & S.) or D.F.F. (P).

(Sgd.) W.L. ? ..... D.F.F.(E. & S.)

(Sgd.) P.Masters ..... D.F.F.(P)

9th June, 1945.

Circulation:-

All Superintendents	2 copies each
D.F.F. (E. & S.)	8 copies
D.F.F.(P)	4 copies

SM(Z)9215-80(14.6.45)D.F.F.(E. & S.)

APPENDIX J

THE DECONTAMINATION OF FILLING FACTORIES FROM EXPLOSIVES

C O N T E N T S

THE DECONTAMINATION OF FILLING FACTORIES FROM EXPLOSIVES

INTRODUCTION

In considering the cleaning and decontamination of Filling Factories from explosive, the purpose for which the factory is to be used should be borne in mind.

The following three purposes are considered as separate categories:-

CATEGORY 1. Complete removal of all plant and equipment and handing over for ordinary industrial purposes, with the machinery and equipment either going in to store for future filling use, or being prepared for trade disposal or scrap.

CATEGORY 2. The oleaning of the factory as far as possible consistent with leaving heavy machinery in position and handing over to another Department for storage though factory is held in reserve as available for future filling.

CATEGORY 3. The cleaning of a part of the factory leaving main equipment in position with the whole factory remaining indefinitely under R.F.F. control but the decontaminated portions being held as a standby but being available for storage purposes.

CATEGORY 1.

General Principles

There are two risk considerations with Filling Factory buildings handed over for ordinary Industrial use.

(a) The risk of fire or explosion from material secreted in floors, ceilings or dirty side, eto. and,

(b) The toxio or dermatitus hazard.

(a) is exemplified by the incident at R.O.F., Swynnerton with the C.E. contaminated floor and also by the incident at R.O.F., Thorp Aroh involving Mercury Fulminate.

Under (b) it should be noted that ordinary Industrial workers will not generally be submitted to the specialist medical supervision as are Filling Faotory operatives and may, therefore, be affected by small toxic concentrations.

In addition, it must be noted that machinery is likely to be contaminated, in positions not accessible, unless the machinery be dismantled in part (e.g. between the jackets of incorporators).

The job should be tackled in several stages; broadly on the following lines:-

All loose explosive should be removed from the shop and obvious explosive removed from fittings, machinery, eto., by steaming or washing off and wiping clean.

The shop should then be washed down, if necessary covering machinery, and using the Fire Service to assist.

Several special aids, such as the use of sodium carbonate spray or sodium sulphite spray, according to the explosive involved, and destroying solutions for initiating explosives, are available.

Where applicable, ducts, filters, machines, shafting, etc., should then be removed from the shop and finally freed from explosive in a suitable Depot arranged for this purpose. In cases where machinery is not to be finally removed it should be thoroughly cleaned, removing and replacing if necessary. Where machinery is to be finally removed for sale or storage, it should be given protective treatment as specified by D.F.F.(E. and S).

The shop itself should then be thoroughly cleaned as indicated later.

The Dirty Side round the shops should be carefully examined, all loose contamination collected and the top surface of soil, if contaminated, removed for burning or, if considered necessary, the whole area should be burned off with suitable precautions. Critical inspection may be necessary to find and remove filled or partly filled ammunition which may be present. Controlled burning off of areas should always be done with suitable precautions and in the presence of Firemen, all personnel remaining behind adjacent cover until the work is deemed complete.

In order that there shall be no doubt as to the degree of decontamination work carried out, it is suggested that each building should have a History Sheet (Appendix A) itemising the work which has been done in the shop, in drains and surrounding dirty side, etc. Reference to S.S.O. cards should be made to ascertain to what uses the shop has been put during its history as this will assist in consideration of the risks and methods of cleaning necessary.

Detailed Operations

Cleaning of Equipment

Cleaning of Ducting

1. Where the contaminent is soluble in water or can be melted by steam (e.g. all TNT based explosives, waxed magnesium compositions and most pyrotechnics), the recommended procedure is as follows:-

   After the removal of the ducting from its position, it should be steamed and flushed as free as possible from explosive and if on examination it is considered necessary, the ducting should be burned out.

2. Where the contaminent is insoluble in water or steam, the recommended procedure is as follows:-

   C.E. is the most likely contaminent in this class and its solubility in acetone and its decomposition by 40% Sodium Sulphite solution should be utilised. All the explosive possible should be brushed from the ducting and, where necessary, the remainder brushed or mopped out with the aid of acetone followed by treatment with 40% Sodium Sulphite solution. If, on examination, further decontamination is required, the burning out procedure should be adopted. If considered desirable

the acetone and/or sulphite treatment may be dispensed with and the burning out treatment used direct.

Note 1. Acetone has certain toxic risks and is also inflamable. Proper precautions should, therefore, be observed in its use.

Note 2. Burning out is likely to destroy the ducting. For valuable ducting required for re-use which must be burned out, a flame thrower or similar apparatus as described in the American booklet will give a less destructive burn. Normal Explosive Burning Safety Precautions are needed at the burning out process and, where the flame jet method is used, only the operator should be within the safety distance and he should be suitably shielded.

Cleaning of Machines

Typical examples of machines for TNT based explosives

3. Incorporators

The routine steaming of the incorporator should be carried out and the plinths, supports, etc., steamed free of explosive. The incorporator vent should be removed and steamed free of explosive as far as possible and taken to the burning ground for burning off. The valve, glands and junction between the end plate and the body should be steamed free of explosive and the lagging stripped and taken away for destruction. The incorporator may then be removed from the shop. The jackets should be dismantled and thoroughly cleaned. The valve and glands should be removed and boiled free in water. If the parts are to be retained in store a preservation coating in accordance with the procedure recommended by D.F.F. (E. and S.) should be applied immediately after decontamination.

4. Swizzle Stick Incorporators

As above.

5. Twisted Anchor Incorporators

As for Incorporators except that there is no fixed vent nor valve and particular attention must be paid to the trunnions and tipping gear.

6. Extruder Machines (Horizontal or Vertical Type)

The normal drill for emptying the hopper and steaming out and removing the scroll and tube should be followed.

The main and scroll clutch assembly should be examined and, if necessary, steamed free of explosive. The plinth, machine bed, extruder track and table, hydraulic or weight gear should be steamed and thoroughly examined. Where trunking exists to feed the hopper, this should be carefully removed for steaming and burning out subsequently. The machine may then be removed, stripped, and all contaminated parts boiled free.

7. Steel Cow Dispensers for Explosives

After routine cleaning these should be dismantled from their position, lagging stripped and destroyed and the machine taken to the boiling-out shop and freed from explosive. Particular examination should be given to the valves and stirrargear to secure their cleanliness. Where constant head devices are in operation these should be cleaned and inspected and then stripped.

Typical Examples of Machines for C.E.

8. Pellet Presses

The routine cleaning should be carried out and punches and moulds removed. Where conveyors are fitted, these should be removed after careful cleaning by brushing and washing down, metal parts being treated with acetone.

The base of the machine should be critically examined and cleaned where necessary, and the machine removed and taken to a decontamination depot where it should be stripped; any smaller heavily contaminated portions being boiled in sodium sulphite solution followed by boiling water.

9. Vertical Bag Extruder Machines

After routine cleaning, the hopper and extruder worm assembly and the mould should be removed for final cleaning. It is doubtful whether the weight gear under the base of the machine can be cleaned without stripping. If this is so, the gear, together with the other removable parts of the machine, should be boiled as for pellet presses in 8.

10. Roller Conveyors

These should be cleaned as far as possible, stripped into the minimum lengths and, if equipment is available, boiled in sodium sulphite solution followed by boiling in water. If the boiling practice cannot be undertaken in lengths, the conveyors should be stripped and given the boiling treatment.

Examples of Machines for other types of Explosive Work

11. Incendiary and Tracer Presses

These should be cleaned as far as possible, stripped right down and boiled free from contamination.

For heavy machines of this type, particular care should be given to the cleaning of the bedding-down plates before removal of the securing bolts.

12. Automatic Weighing Machines for:-

(a) Neonite etc - All parts of the machine should be very carefully examined and cleaned to secure freedom from neonite dust. It is not considered essential for these machines to be boiled to render them free but the use of suitable suction plant will assist in removing traces of dust from inaccessible positions in the machine. Passing sawdust through the machine is recommended. It is quite likely that explosive exists inside the machine body and perhaps even underneath the

bed-plate, therefore the machine should be removed with care.

(b) Smoke Compositions - The machine is likely to be heavily contaminated with smoke composition dust and, after routine cleaning, all suspected portions should be stripped and, where possible, boiled free in boiling water.

13. Cleaning of Wood fixtures

Where wood fixtures are even lightly contaminated, unless a known outlet exists for filling or explosive use, they should not be sold, but should be destroyed.

Typical examples are as follows:-

(a) Metal-covered Process Tables

The metal covering should be removed carefully, bearing in mind the possibility of explosive between it and the wood-work. The metal can then be cleaned. The wood beading should be stripped and destroyed and the table inspected and cleaned, or destroyed, wholly or in part, if considered necessary.

(b) Lino-covered Process Tables

The wood beading and the linoleum, if contaminated, should be stripped and destroyed. The table to be dealt with as in Metal-covered Process Tables.

(c) Mirror Frames, for instance, C.E. Pressing Shops

If contaminated, the frame beading should be removed from the mirror and destroyed.

Cleaning of Shops and Dirty Side Etc.

Lead Azide Buildings

14. Precipitating Building

After normal cleaning, the gulley cover should be removed carefully and the whole precipitating cubicle washed down by hose spray. The sodium azide delivery tube and jet should be flushed through with water, filled with destroying solution as far as possible, and allowed to stand for about 48 hours. The precipitating pan, trunnions and suspension gear and water connections should be carefully examined and, if necessary, washed until no more explosive remains, the ferriccholoride test should be used in doubtful cases. The precipitating pan and other equipment should then be dismantled and taken to a Depot for further examination and decontamination, if necessary.

The Lead azide drain sump outside the building should then be plugged off and filled with destroying solution at the rate of 15-lbs of sodium nitrite and 2 Winchester quarts of acetic acid to the approximate 20 gallons of water in the sump. The level of the solution should be so arranged to fill the gulley in the precipitating chamber up to the surface of the rubber flooring.

(Note: There is a considerable toxic hazard with destroying solution, and personnel should remain for as short a time as possible in the building)

The solution should stand approximately 48 hours. Meantime the drain from the sump should be identified and plugged at its outlet into the main drain. After the period of standing, the syphon should be started on the sump and the plugged portion of the drain filled with destroying solution. This should stand at least a further 24 hours. The drain should then be unplugged and, with large quantities of water running down the main drain, the destroying solution in the sump and drain should be discharged. Following this, the precipitating compartment gulley, the sump and the drain should be well flushed with water and the compartment generally hosed down again. The rubber flooring should then be cautiously removed, well washed with destroying solution, and taken to the Depot for examination. The floor, gulley, sump and drain should again be treated by the destroying solution process and followed by a further flush down.

(Note: There is a possibility when treating big quantities of lead azide with destroying solution without stirring that a secondary re-action may take place carrying an explosive hazard. This should be borne in mind when decontaminating sumps etc.)

15. Drying Compartments

All loose equipment should be carefully cleaned and removed to the Depot and the cubicle passage and control cubicle wall hosed down, including the walls and ceiling. The washings can be squeegeed from the compartments. All fixed equipment and the rubber flooring should then be removed and taken to the Depot and the compartments again hosed down and dried off.

Careful examination should be given to wainscot, cornices, etc. at the removal stage. If contamination exists, the stripping of the building should be delayed until this is cleaned.

16. Sieving Compartments

After normal cleaning, the machine should be critically examined and all signs of azide carefully brushed off. When satisfied that the contamination is at the minimum, the washed machinery should be removed to the Depot. The ceiling, walls and floor should than be thoroughly hosed down and squeegeed free from water. The rubber flooring should then be removed with similar precautions as in 14 and 15.

17. Solution Mixing Buildings

(a) Lead Acetate

This should be carefully hosed down and the equipment removed.

(b) Sodium Azide

On account of the risk of formation of either hydrozoic acid or metallic azides, these buildings should be hosed down thoroughly after the cleaning and removal

of loose equipment to the Depot and the cleaning of fixed equipment with copious quantities of water and critical examination for contamination.

The fixed equipment should then be removed to the Depot. The drain outlet into the main should then be identified, plugged and treated with destroying solution similarly to the lead azide sump and drain. The buildings, floors and gulley should then be hosed down to flush the drain with further water.

Fulminate Buildings etc.

18. Unheading Platform and Dirty Side adjacent

(a) The Unheading Platform and the immediately adjacent Dirty Side should be well wetted with water to limit the risk of explosion should any pockets of fulminate of mercury exist, and treated with Sodium Thiosulphate solution, whilst wet samples of the soil should be taken and sent to C.C.I. for test of presence of fulminate of mercury.

(b) The outlet from the Unheading Platform to the drain should be plugged and the platform filled with 10% solution of Sodium Thiosulphate. Where any cracks occur in the asphalt and above the level of the destroying solution, a channel of luting or other material should be built up and filled with Sodium Thiosulphate solution also. This should remain at least 24 hours. The brickwork should be thoroughly sprayed with Sodium Thiosulphate solution. The sump alongside the Unheading Platform should be carefully washed down and filled with Sodium Thiosulphate solution. After standing for at least 24 hours, the destroying solution in the platform and in the sump should be run off in to the sump compartment, the whole unit again to be washed down thoroughly and the sump and compartment emptied. Careful examination should then be made of the sump and if further contamination is suspected, the destroying process should be repeated etc.

After completing the above, the Dirty Side around the Unheading Unit should be allowed to dry out if possible, and any contamination removed by a controlled burning off using Diesel oil and white spirit. This can be done by spraying a mixture of the two oils over the suspected area and arranging for their ignition by remote control, the process being conducted with suitable fire cover. Firemen should take cover behind the nearest suitable mound or traverse and should carry at least one loaded diffuser nozzle hose.

19. Wet Storage Building

The building should be thoroughly hosed down with water, as much as possible of the effluent from this should be collected and treated with Sodium Thiosulphate solution. All ledges, pipes, niches, lampshades etc., should be sponged off with Sodium Thiosulphate solution. The storage tanks should then be drained, treated with Sodium Thiosulphate solution and washed out. They should then be carefully tipped to expose their base and platform which should also be hosed down, all surfaces to be sponged with

Sodium Thiosulphate solution and finally hosed down again. It is preferable to remove the tanks at this stage from the building to a suitable decontamination centre where they should be carefully examined for flaws in the lead lining and re-cleaned or stripped if necessary. The building may then be given a final wash down.

The junction between the shop floor and the cleanway and the Emergency exit should be critically examined and cleaned and any wood gratings removed, if necessary, for destruction. The shop floor should be critically examined. If this is of linoleum, its condition will determine whether it has to be removed and destroyed. If of asphalt, any cracks should be treated as recommended in the case of 18(b) above.

The Dirty Side should be treated as recommended for Fulminate Unheading area.

20. Fulminate Washing and Draining Shop.

The building should be well washed down, ledges, etc., sponged with Sodium Thiosulphate solution and rope pulley fixtures etc., removed. The ropes should either be destroyed or decontaminated in Sodium Thiosulphate solution. Similar remarks apply as in 19 to the junction between the shop floor and the cleanway and Emergency exit, the shop floor and the Dirty Side.

21. Fulminate Drying Shops

These should be well hosed down, ledges etc., sponged with Sodium Thiosulphate solution, drying baths removed for further decontamination and the buildings washed down again. As much as possible of the effluent in all cases should be collected and treated with Sodium Thiosulphate solution. Similar remarks as in 19 apply to the junction between the shop floor and the cleanway and Emergency exit, the shop floor and the Dirty Side.

22. Weighing Shop

The Equipment should be removed and decontaminated and the shop treated similarly to 21 above.

23. Mixing Shop

This should be treated similarly to 22 above.

Detonator and Cap Filling Units

24. Filling Shops

After routine cleaning, all loose fixtures should be removed for further attention.

(a) Filling Cubicles

These should be critically examined so far as ledges, wainscots etc., are concerned. Where wainscots are not tape sealed, these should be treated with suspicion and should, in due course, be stripped.

In shops used for fulminate compositions, all likely places of contamination should be carefully sponged

off with swabs soaked in Sodium Thiosulphate, although this should not be undertaken until the main contamination has been removed by brushing etc.

In buildings used for azide, this preliminary cleaning procedure should be by careful brushing only.

Wall cupboards and transit hatchways should be carefully brushed and washed down. The machine controls should be disconnected carefully, the machine footings should be critically examined for contamination and, when it is clear that they are clean, the machines should be removed for dismantling and decontamination elsewhere.

Ventilators in the cubicles should be removed with care and either washed or burned off, particular attention being paid to the cleaning of the ventilator orifice in the wall.

(b) The Main Body of the Shop

This should be treated similarly to the filling cubicles in that all ledges, wainscots, pipes, lighting fittings etc., should be freed of explosive dust.

Ventilators should be removed carefully and examination given to the shop floor, junction between the floor and the cleanway, and the Dirty Side via the Emergency Gate, with removal of portions suspected of serious contamination.

The whole shop should then be thoroughly hosed down. If a false ceiling exists a section of this should be removed and the dust within the cavity examined for explosive. If contaminated, the false ceiling should be removed and either cleaned or destroyed.

Attention should be given to the dirty side round the shop and a critical examination made of all likely places where live detonators or caps may have accidentally been deposited.

25. Shops in which C.E. has been used

After routine cleaning down, all fixtures, such as tables, conveyors, small machines etc., should be removed from the shop to a decontamination centre. If filters and ducting are present in the shop, the filters should be thoroughly cleaned and if of the wet type flushed and refilled with water; the ducting, as far as possible, removed.

The walls, ceiling and floors, lamp fittings, pipes, etc., should be thoroughly hosed down. The Fire Brigade Diffuser Equipment is satisfactory for this purpose. Having squeegeed all the floor, a spray branch should be used to feed diluted sodium sulphite solution over the walls, floor and ceiling. This will (a) act as an indicator and (b) as a decontaminant. A further hosing should be given. The floor should be examined and, if of the asphalt type and suspected of softening and contamination, a sample portion should be removed with precautions and tested for inflamability. If inflamable the appropriate portion should be removed and burned.

If a false ceiling exists in the building, a small section of this should be removed and as big an area as possible of the dust above the ceiling collected and submitted to chemical examination. If the contamination per square foot is found to be high, the false ceiling should be removed and the cleaning treatment extended to the enclosed portions.

Where ventilators, louvre boxes etc., exist in the walls of the building, these should be examined and cleaned where possible; if of wood, they may need to be removed and the wood destroyed.

The junction between the shop floor and the cleanway and similar positions at the Emergency exists to the dirty side should be examined. Wooden gratings, etc., from these positions should, if considered necessary, be removed and destroyed - explosive contamination at these positions being carefully dealt with.

The dirty side around the shop, especially on the borders of the porch, cleanways, and outside the Emergency exists, should be examined and, if necessary, the top surface carefully removed and turned in or, if considered desirable, burned off.

Any cracks in the cleanway immediately adjacent to the porch, the porch floor or the floor of the room, should be treated with suspicion and, if necessary, the floor around the cracks should be removed and burned. Where lino covering is used, this should be critically examined for cracks and crevices and, if considered necessary, removed and destroyed. Wood wainscots round the walls of the building unless sealed by taping, should also be critically examined and again, if necessary, removed.

26. Shops which have been used for T.N.T. work

As for C.E. but using steam and water or hot water to melt off the contaminant and using Sodium Carbonate solution instead of Sodium Sulphite.

Shops in which Minol, RDX/TNT, Torpex, Pentolite, etc., have been used can be dealt with similarly to T.N.T. shops.

In shops containing incorporators where natural draught ducting is carried up through the roof from the incorporator, an examination should be made of the roof and any splashes or sublimation of explosive removed.

Where roofs are covered with tarred felt, contamination areas of felt should be removed and destroyed, replacement being effected quickly.

27. Shops handling Aluminium Powder

After routine cleaning and removal of light fixtures, care should be taken that any installations for handling aluminium powder are completely emptied.

Trunking or ducting should be cleaned and any remaining machinery wiped down with oil and covered.

The shop can then be sprayed down, particular attention being paid to crevices, false ceilings, etc.

28. Specialist Units involving large quantities of High Explosives

Such installations as the heavy bomb unit at Elstow will require special treatment on account of the multiple floors, gantries, etc. The principles involved are exactly similar to ordinary T.N.T. shops in that steam and water washing are satisfactory for removing contamination. But the positioning of incorporators etc., makes it difficult to guarantee cleanliness of the building without their removal.

The multiple extraction ducting should, in any case, be removed and steamed and/or burned out, the filter installations being dealt with specially on account of the probability of high contamination.

It is considered that this particular problem is beyond the scope of this Brochure and should be dealt with by agreement on the spot.

29. Shops in which Cordite, Neonite, NCT, NH, has been used

After routine cleaning, small fixtures should be removed for further decontamination. All niches and crevices in the shop, particularly wainscots, should be critically examined and any explosive removed by a suitable suction apparatus. The junction between the shop floor and the cleanway, the shop porch and Emergency exit doorways should be examined and, where necessary, wood gratings, etc., removed and the position cleared of explosive. Considerable concentrations have been found in such places.

Where machinery must remain in the building, this should be critically cleaned and examined, and covered for the wash down operations. The building should then be sprayed down with the diffuser nozzle as in the case of C.E. shops and the false ceiling, if any, louvres, ventilators etc., dealt with.

Where propellent powder has trodden in to the floor, a sample should be tested for combustability and, if considered necessary, the floor may be removed. Similarly with linoleum floors, critical examination for cracks and crevices should be made and, dependent upon the condition, it may be found desirable to move the lino for destruction. In any case, an inspection beneath the lino should be made.

In some cases installations have been made in cartridge assembly shops where ducts have been cut into the floor for hydraulic or pneumatic lines - special attention should be given to such installations on account of the risk of harbouring explosive.

The dirty side round the shop should be examined and if contamination is suspected it may either be removed or burned off. Burning off should only be attempted for small scattered quantities and under proper precautions.

30. Shops in which Pyrotechnic Compositions have been used

This applies jointly to pyrotechnic flare and candle compositions as well as to gun and small arms tracer and incendiary compositions.

Because of the dusty nature of these compositions, all crevices, gaps, ledges and enclosed spaces such as false

ceilings should be suspected as being heavily contaminated. Linoleum, asphalt flooring and wood fixtures are also likely to be heavily contaminated because of the waxes in the compositions. Little or no toxic risk exists, however, so that the decontamination can be narrowed down to combat the fire hazard only.

Machines, especially screwed portions and bearings and positions of lubrication are likely to be so contaminated that only stripping down and boiling may free them from explosive.

After routine cleaning, machinery, especially the footings and parts mentioned above, all crevices in the shop, wainscots, lampshades and the junction between the shop floor and the cleanway etc., should be examined and freed from explosive by suitable brushing, wiping or suction apparatus where necessary, wood gratings and box ventilators should be removed. Where machinery has to remain in the building, this should be covered and the walls, ceiling and floor either steamed down and sprayed with cold water or washed down with water above the melting point of the wax used in the composition. Repeated washings may be necessary. False ceilings, etc., should be examined as in the case of C.E. Shops and, if necessary, stripped.

The dirty side round the building should be examined for contamination and badly contaminated portions removed for burning or turned in whilst wet, or burned off.

31. Shops used for Gunpowder and Fuze Powder work

Water will completely phlegmatise gunpowder and will dissolve the nitrate or other oxidising constituent. For this reason, copious washing down with water is the recommended method for cleaning down such buildings. The remarks with regard to crevices and niches, false ceilings, cracks or covered conduit channels apply as in the case of other types of buildings.

32. Wooden Buildings

Some factories may be equipped with a few wooden buildings. These, if they have been used for explosive work especially with dusty explosives, will have a big hazard because of the secretion of explosive in the cavity between the outside wall and the lining. The recommended procedure is as follows:-

The shop should be cleaned as indicated above according to the type of explosive involved and the interior linings gently prised free. The cavity should be cleaned using, as far as possible, a non sparking suction apparatus which delivers the explosive into the oil filter. The walls should then be washed down and cleaned by the relevant process, dried and re-painted internally.

The linings, if of wood or similar material, should be removed to the Burning Ground and destroyed. If of material impervious to explosive, it may be possible for them to be cleaned and re-placed.

In certain cases the contamination of the walls of the building may be such as to make it necessary to dismantle the building and destroy it, but any such action should be

advised to Headquarters before being undertaken.

33. Removal of Contaminated Asphalt Floors

Although no incidents have occurred so far, even with heavily contaminated floors, the operation of floor removal is considered a little risky.

Where contamination is such that it is thought advisable to remove the floor, the actual work of removal should be done under water. This can readily be achieved by making a shallow channel of the area to be removed with the use of luting or clay and flooding this channel to a depth of about 1/2 an inch.

Where samples are to be taken from floors suspected as being heavily contaminated, the flooding procedure should be used also. Whenever a contaminated floor is being removed or made good it is advisable to have a fireman in attendance with a loaded hose.

When burning contaminated asphalt flooring, only single layers should be burned with the contaminated surface upwards. This is necessary because in piles or heaps of contaminated asphalt there is a tendency for the material to melt in the upper layers and blanket the explosive contamination in the lower layers. Satisfactory ignition can be achieved by sprinkling the surface of the contaminated asphalt with white spirit and igniting by cordite. The resulting debris should be buried.

34. Surface of Effluent Drains and Rubble Drains

(a) Surface Effluent Drains

Traps and sumps should be examined and emptied of explosive. The junction between each surface drain and the main drain should be found and exposed while large quantities of water are being flushed down the subsidiary effluent drain. If considered necessary, sections of the effluent drain pipes should be brushed through and again flushed.

(b) Rubble Drains

The action here depends on the degree of contamination. Where the dirty side round the rubble drain is not badly contaminated, a position in the drain near the shop should be examined. This can readily be done by flooding the position concerned and removing the rubble for chemical examination. Where contamination is found to be very light, only that portion of the drain leading to the shop need be removed and transported to the Burning Ground. Where contamination is heavy, a similar test should be made on the drain at a point further from the shop, and so on.

35. Burning Ground

At the close of the contamination process for the factory, the Burning Ground itself will need to be freed from explosive. The whole area should be carefully scrutinised and all extraneous material collected. Any such material thought to contain explosive should be dealt with as applicable.

Areas suspected as being contaminated with explosive should be burned off by remote control using cordite or neonite. It is expected that considerable quantities of surplus propellent will be available and, if this is so, the propellent should be laid in areas to a depth of between 3-in. and 6-in.

After each area has been burned, it should be well watered down and the adjacent area should be treated and so on. When the whole of the suspected areas have been so burned over, they should be roped off and in due course ploughed in after the ground has become naturally wet.

CATEGORY 2.

In this event, most of the cleaning described under Category 1 is desirable. Machinery, however, which is assumed to be required for filling work again, should not normally be removed or taken to pieces unless previous experience has shewn that there is a risk of contamination on a scale likely to cause injury if it were struck or ignited by a flame. Certain groups or portions of a group, such as the Lead Azide manufacturing plant, might well be barriered off and retained exactly as it stands after cleaning, as removal of flooring etc., may be undesirable in the event of an early re-start. Fuze powder plants, fulminate drying shops etc. might be similarly treated, and some detonator shops, unless these are definitely required for storage.

CATEGORY 3.

This assumes control by R.F.F. indefinitely, in a factory partly working. In these circumstances, the Superintendent would clean the closed portion either as a normal group temporarily closed but available for future work, or if required for storage of any kind, as set out in Category 2.

In this last case it might be possible to limit the work of cleaning on the understanding that the Superintendent maintains semi-clean conditions on the group concerned involving ordinary Danger Building and Contraband Rules.

APPENDIX 'A'

DECONTAMINATION HISTORY SHEET

Building No.	Type of Explosive and Use.	Work done on Building (A)	Work done on Machines (B)	Work done on Dirty Side (C) Drains etc.

Suggested Typical legend to be filled in against each Building in each column

(A)

1. Shop washed down.
2. Sprayed sodium sulphite.
3. False ceiling examined.
4. Floor examined.
5. Lino removed.
6. Portions of asphalt floor removed.
7. Roof cleaned.

etc., etc.

(B)

1. Machines cleaned and removed.
2. Ducting dismantled and cleaned.
3. Machines cleaned in situ.

etc., etc.

(C)

1. Loose cont. removed.
2. Rubble drains checked and picked up where necessary.
3. Surface drain cleaned.
4. Contaminated top surface removed.
5. Contaminated area burned off.

etc., etc.

APPENDIX B

_____ FACTORY

BUILDING CLEARANCE CERTIFICATE

THIS IS TO CERTIFY THAT BUILDING No._____ HAS BEEN CLEANED AND DECONTAMINATED, IN ACCORDANCE WITH THE PAMPHLET ISSUED BY D.F.F.(P), TO THE BEST OF OUR ABILITY AND IS CLEAN AND SAFE SO FAR AS WE CAN REASONABLY ASCERTAIN BY INSPECTION.

(Sgd.) .....
Superintendent, Royal Ordnance Factory.

BUILDING ACCEPTED AS ABOVE STATEMENT.

(Sgd.) .....
for D.F.F. (E. and S.) M. of S.

Date .....

EXPLOSIVE ACCIDENTS OCCURRING AT FILLING FACTORIES

1st January 1941 to 1st May 1945

A. Courts of Enquiry Presided over by H.M. Chief Inspector of Explosives or his Appointed Deputy.

Date	Operation during occurrence of Explosion or Fire	Circulation No.
1. R.F.F. Chorley		
11. 2.41	Final examination and counting of A.S.A. dets.	F.2
19. 3.41	Weighing of A.1 composition	F.3
4. 4.41	Sieving lead styphnate	F.4
5. 4.41	Examining, counting, gauging of A.S.A. dets.	F.5
18. 4.41	Assembling No.151 Fuze	F.7
22. 9.41	Filling 9.2" How. Shell with 70/30 amatol	F.28
2. 3.42	Weighing lead styphnate	F.41
8. 7.42	Assembling an A.A.D. shell	F.72
16.11.43	Sieving lead azide	F.215
28.10.44	Assembling fuze No.850	F.299
2. R.F.F. Bridgend		
17. 1.41	Stove drying A.S.A. detonators	F.1
18. 5.41	Assembling and stemming No.119 Fuzes	F.10
1.11.41	Filling 3.3/4-oz. Naval Smoke boxes with S.R.568	F.22
15.11.43	Filling and pressing stars for 1.1/2-in.Ctge. Signal Green	F.217
20.12.43	Pressing 33.1/4-oz. C.E. pellets	F.225
3. R.F.F. Glascoed		
12. 4.41	Gauging 2 pdr. H.E. Q.F. Shell	F.6
19. 9.41	Filling 4-in. Mk.I.D. shell with T.N.T.	F.19
4. R.F.F. Hereford		
12. 9.41	Milling amatol	F.25
30. 9.42	Transit of 25 pdr. shell	F.89
30. 5.44	Fire in Bomb filling shop	F.274
5. R.F.F. Swynnerton		
24. 3.43	Storing smoke composition P.N.421	F.142
20.12.43	Destroying S.R.346 B. on Burning Ground	F.228
1. 3.44	Premixing pot. nitrate and calcium silicide.	F.257
19. 4.44	Unpacking 6 gr. Z/Y detonators ex R.F.F.Bridgend	F.272
19. 3.45	Fire on floor of shop impregnated with C.E.	F.321

Date	Operation during occurrence of Explosion or Fire	Circulation No.
6. R.F.F. Risley		
27.10.41	Drying of detonators	F.23
20. 1.42	Externally varnishing 4 gr. Z/Y detonators	F.35
15.11.42	Storing lead azide	F.99
28. 9.43	Transferring mercury fulminate to p.m. pot	F.208
7. R.F.F. Kirkby		
4. 3.42	Cleaning detonator filling machine	F.42
12. 4.42	Mixing A.S.A. Composition	F.49
26.11.42	Mixing composition S.R.399	F.105
23.12.42	Dropping a p.m. pot containing lead azide	F.114
21. 5.43	Depositing Initiatory Composition in Magazine	F.167
22. 2.44	Becketting and waxing Fuze Mine Contact No.3 Mk.1	F.255
15.9.44	Clustering 8 lb. 'F' Bomb	F.292
8. R.F.F. Aycliffe		
20. 2.42	Storing .303-in. Cap Composition	F.39
6. 6.42	Loading 3-in. H.E. Shell O.S.B.	F.70
20.10.43	Pressing H.E. into 4.2-in. T.M. Bomb	F.207
10. 3.44	Drying 6 gr. Z/Y detonators	F.262
2. 5.45	Extruder-filling 4.2-in. T.M. bomb	F.329

B. Courts of Enquiry Presided over by M.A/C.S./R.O.F./W. or his Appointed Deputy.

Date	Operation during occurrence of Explosion or Fire	Circulation No.
1. R.F.F. Chorley		
14. 3.42	Breaking down No.151 fuze	F.46
10.12.42	Pressing 25 pdr. H.E. shell	F.108
10.12.42	Filling magazine of fuze No.221 by vibrator	F.109
15. 4.43	Transporting lead azide	F.155
13. 5.43	Testing A.A.D. bombs	F.162
25.10.43	Transporting fuze portions of A.A.D. bombs Mk.4	F.209
19. 3.44	Granulating and sieving fuze powder S.R. 227A	F.258
15.11.44	Sieving lead azide	F.198
2. R.F.F. Bridgend		
19. 5.42	Spontaneous ignition of 25 pdr. coloured smoke contr.	F.57
10. 6.42	Gauging 5 gr. A.S.A. detonators	F.73
15. 6.42	Gauging 5 gr. A.S.A. detonators	F.73
18. 9.42	Externally cleaning 5 gr. A/Z detonators	F.92
18. 9.42	Examining Fuze No.501	F.87
9. 3.43	Filling caps No.16 Mk.1 with A.1 composition	F.148
23. 3.43	Packing 10 gr. fulminate detonators	F.144
4. 5.43	Packing 10 gr. fulminate detonators	F.157
7. 5.43	Filling 1.7 gr. detonators with A.1. composition	F.163
2. 7.43	Visually examining 5.5 gr. fulminate detonators	F.173
4. 7.43	Pressing 4 gr. Z/Y detonators	F.174
26. 8.43	Filling 1.1/2-in. brown smoke Puff with SR.223B	F.192

Date	Operation during occurrence of Explosion or Fire	Circulation No.
2. R.F.F. Bridgend (Cont.)		
26. 8.43	Filling caps No.12 Mk.3 with A.1 composition	F.193
14. 3.44	Premixing 'A' composition	F.252
10. 5.44	Internally varnishing 5 gr. A/Z detonators	F.269
19. 5.44	Rectifying 4-in. A/S flare	F.271
24. 5.44	Drying composition PN 443	F.275
6.10.44	Transferring 5 gr A/Z detonators	F.288
6.10.44	Transferring 5 gr.A/Z detonators	F.288
10.11.44	Filling Brown Smoke puffs	F.294
15.11.44	Drumming 5 gr. A.S.A. detonators	F.296
15.11.44	Drumming 5 gr. A.S.A. detonators	F.297
7.12.44	Packing 5 gr. A.S.A. detonators	F.302
12.12.44	Packing 5 gr. A.S.A. detonators	F.304
12.12.44	Examining 5 gr. A/Z detonators	F.305
4. 1.45	Packing 5 gr. A.S.A. detonators	F.307
6. 1.45	Pressing GP pellets	F.308
12. 4.45	Transferring 5 gr. A/Z detonators	F.317
13. 4.45	Pressing G.P. pellets	F.318
18. 4.45	Stemming 3-in. UP igniters with S.R.371C	F.320
5. 5.45	Mixing composition SR.233B	F.327
13. 7.45	Screw gauging fuzes No.117	F.333
3. R.F.F. Glascoed		
28. 2.45	Filling Grenades No.83 with PN 473A	F.312
4. R.F.F. Swynnerton		
3. 9.41	Preparing reject detonators for destruction	F.21
17.11.41	Gauging 20 m.m. H/S Ball otge.	F.26
26.12.41	Filling 6 gr. Z/Y detonators	F.38
1. 3.42	Counting and packing 5 gr. ASA detonators	F.47
27. 3.42	Destruction of lead azide/C.E. on Burning Ground	F.48
17. 4.42	Weighing and packing 6 gr. A/Z detonators	F.53
15. 5.42	Filling 6 gr. fulminate detonators	F.63
15. 5.42	Counting and packing 6 gr. fulminate dets.	F.64
11. 6.42	Gauging 20 m.m. Oerlikon H/T r. round	F.66
14. 6.42	Counting and packing 6 gr. fulminate boosters	F.71
25. 6.42	Gauging 6 gr. fulminate boosters	F.76
30. 6.42	Handling bonded 6 gr. fulminate boosters	F.77
11. 8.42	Preparing 6 gr. Z/Y detonators for destruction	F.78
11.10.42	Extracting 6 gr. Z/Y detonators	F.96
19.11.42	Weighing mercury fulminate	F.101
28.12.42	Washing lead azide	F.112
1. 1.43	Burning contaminated waste	F.120
6. 1.43	Packing 6 gr. Z/Y detonators	F.122
3. 4.43	Sampling cap composition	F.164
12. 4.43	Mixing A.1 cap composition	F.160
13. 8.43	Discing 6 gr. fulminate detonators	F.195
17. 1.44	Sieving lead azide	F.229
16. 2.44	Drying of 6 gr. Z/Y detonators	F.240
25. 2.44	Fuzing 20 m.m. H/S HE/I shell	F.245
15. 3.44	Filling 6 gr. Z/Y detonators with lead azide	F.263
31. 5.44	Mixing S.R.370	F.276
8.11.44	Weighing cap composition	F.295
13.11.44	Unpacking 6 gr. Z/Y detonators ex RFF Bridgend	F.300
4.12.44	Drying 6 gr. Z/Y detonators	F.306
24. 5.45	Internal cleaning and extracting 6 gr. Z/Y detonators	F.328

Date	Operation during occurrence of Explosion or Fire	Circulation No.
5. R.F.F. Risley		
26. 2.42	Drying 4 gr. Z/Y detonators	F.44
27. 4.42	Filling 3-in. U.P. Igniters with S.R.371C	F.55
29. 4.42	Counting and packing 4 gr. Z/Y detonators	F.56
27. 5.42	Counting 4 gr. Z/Y detonators	F.60
2. 6.42	Mixing A.1 composition	F.67
9. 6.42	Drumming 4 gr. Z/Y detonators	F.68
10. 9.42	Converting fuzes No.221 T & P to fuzes No.221T	F.85
10. 9.42	Cleaning 5 gr. A/Z Detonators	F.86
21. 9.42	Weighing lead azide for fuze No.251 sleeves	F.93
19. 1.43	Machine filling 5.5 gr. fulminate boosters	F.124
29. 1.43	Counting and packing 5 gr. ASA detonators	F.131
12. 2.43	Filling caps with A.1 composition	F.133
13. 2.43	Filling 1.7 gr. detonators with A.1 composition	F.132
11. 3.43	Weighing A.S.A. composition for filling detonators	F.149
13. 8.43	Packing 6 gr. Z/Y detonators	F.188
8. 9.43	Cleaning lead azide filling machine	F.197
14. 2.44	Pressing 6 gr. Z/Y detonators	F.236
12. 3.44	Precipitating lead azide	F.249
2. 3.45	Firing primer in 37 m.m. Ctge Case	F.313
25. 4.45	Destroying a fuze No.231 Mk.2	F.324
6. 5.45	Extracting grenades No.83	F.326
6. R.F.F. Kirkby		
12.12.41	Varnishing 4 gr. Z/Y detonators	F.34
3. 2.42	Externally varnishing 4 gr. Z/Y detonators	F.37
28. 6.43	Mercury fulminate split on ground by carrier	F.180
1.11.43	Proofing Fuze Mine Contact A/T No.3 Mk.1	F.213
27. 5.44	Explosion in closed detonator magazine	F.277
7. R.F.F. Thorp Arch		
14. 8.42	Drying 6 gr. fulminate detonators	F.80
14.12.42	Pressing tracer pellets for 25-pdr shot	F.111
10.11.43	Removing waste init. compo. from bucket	F.211
17.12.43	Cutting back 20 m.m. S.A.P./I shell	F.221
29. 3.45	Unauthorised person killed by fulminate explosion	F.315
8. R.F.F. Aycliffe		
5.11.42	Externally varnishing 6 gr. Z/Y lugless dets.	F.102
5.11.42	Drumming 6 gr. Z/Y detonators	F.103
7. 1.43	Inserting ballistite cartridge in T.M. bomb	F.119
12. 1.43	Filling 6 gr. Z/Y detonators	F.123
29. 3.43	Removing 0.55-in. caps from the plate	F.150
5. 4.43	Packing reject 6 gr. Z/Y detonators for destruction	F.153
10. 7.43	Precipitating lead azide	F.175
3. 8.43	Filling 20 m.m. caps with A.1 composition	F.189
1.10.43	Breaking down 20 m.m. Oer. H/I/T rounds	F.205
3.11.43	Mixing smoke composition S.R.269M	F.214
8.11.43	Mixing smoke composition S.R.269M	F.214
24.11.43	Filling 0.5-in. Browning caps	F.216
8. 3.44	Mixing A.1 composition in Jelly Bag Mixer	F.248
2. 5.44	Destroying fuzes No.426	F.268
23. 3.45	Burning Waste High Explosive	F.314

Date	Operation during occurrence of Explosion or Fire	Circulation No.
9. R.F.F. Healey Hall Mill		
5. 6.43	Assembling 3-in. T.M. Bombs	F.171

C. Courts of Enquiry Presided over by Factory Superintendents or their Appointed Deputies; or Reports forwarded by Superintendents.

Date	Operation during occurrence of Explosion or Fire	Circulation No.
1. R.F.F. Chorley		
28. 8.41	Precipitating lead azide	F.18
7. 1.42	Precipitating lead azide	F.50
29. 7.42	Transferring 5 gr. A.S.A. detonators to oil for destruction	F.75
11.11.42	Proofing of A.A.D. bombs No.7 Mk.A Type K	F.100
12.11.42	Grading 5 gr. A.S.A. detonators	-
12.11.42	Pressing No.21 Electric detonators	F.104
30.12.42	Transferring mercury fulminate to Hopper	F.115
7. 1.43	Pressing R.D.202 in fuze time ring	F.121
23. 2.43	Assembling 5 gr. A/Z detonator into fuze	F.138
17. 3.43	Pressing 55 gr. G.P. pellets	F.140
23. 3.43	Finishing 5 gr. A.S.A. detonators	F.146
7. 4.43	Filling 5 gr. A.S.A. detonators	F.152
17. 5.43	Extracting 5 gr. A.S.A. detonators	F.168
8. 6.43	Grading 5 gr. A.S.A. detonators	F.172
1. 7.43	Drumming 5 gr. A.S.A. detonators	F.176
20. 7.43	Drumming 5 gr. A.S.A. detonators	F.183
30. 8.43	Wiping out waste bucket containing A.S.A.	F.202
2.12.43	Drumming 4 gr. Z/Y detonators	F.230
21.12.43	Filling fuze No.119	-
30.12.43	Brushing up surplus lead azide	-
18. 1.44	Closing 4 gr. Z/Y detonators	F.231
7. 2.44	Counting 6 gr. Z/Y detonators	F.235
10. 2.44	Closing 5 gr. A.S.A. detonators	F.237
25. 2.44	Extracting 5 gr. A.S.A. detonators	F.244
5. 3.44	Accidentally dropping tray of 5 gr. A.S.A. detonators	F.251
14. 3.44	Drumming 5 gr. A.S.A. detonators	F.253
18. 3.44	Closing 5 gr. A.S.S. detonators	-
27. 3.44	Cleaning 5 gr. A/Z detonators	F.259
6. 6.44	Filling and pressing Tracers No.14 with S.R.399	-
20. 6.44	Inserting Fuze No.370 lead azide sleeves into folder	-
5. 7.44	Extracting 5 gr. A.S.A. detonators	-
21. 7.44	Drumming 5 gr. A.S.A. detonators	-
21. 7.44	Drumming 5 gr. A.S.A. detonators	-
31. 8.44	Drumming 5 gr. A.S.A. detonators	F.286
11. 9.44	Discing and washering 5 gr. A.S.A. detonators	-
12. 9.44	Drumming 5 gr. A.S.A. detonators	F.287
19.10.44	Pressing S.R.209P into T.I.Candles	-
24.10.44	Drumming 5 gr. A.S.A. detonators	-
24.10.44	Pressing pellets for fuze No.119	-
18.11.44	Internally varnishing 5 gr. A.S.A. detonators	F.301
28.12.44	Drumming 5 gr. A.S.A. detonators	-
11. 1.45	Closing 5 gr. A.S.A. detonators	-
17. 2.45	Preparing fuze No.119 for sealing proof	F.311
28. 2.45	Extracting 5 gr. A.S.A. detonators	-
19. 4.45	Filling detonator watertight	-

Date	Operation during occurrence of Explosion or Fire	Circulation No.
2.	R.F.F. Bridgend	
5. 5.41	Crimping guard on ballistite ctge. for T.M.bombs	F.16
6. 5.41	Mixing A.1 composition	F.17
22. 5.41	Pressing G.20 pellets	F.13
3. 6.41	Transferring A.1 composition from mixing machine	-
14. 6.41	Proofing 5 gr. A/Z detonators	F.14
23. 6.41	Pressing Life Saving Rockets	-
25. 8.41	Transferring 5 gr. A.S.A. detonators from carrying box	-
15.10.41	Mixing A.1 composition	-
23.10.41	Sieving lead styphnate	F.29
27.10.41	Internally cleaning 5 gr. A/Z detonators	-
12.11.41	Ignition of No.75 Grenade igniters	-
17.11.41	Transporting reject detonators to Waste Station	F.30
24.12.41	Pressing G.P. pellets	-
8. 1.42	Destroying igniters for Grenades No.75	F.33
8. 1.42	Drumming 5 gr. A.S.A. detonators	F.27
29. 1.42	Sieving lead styphnate	F.31
10. 2.42	Extracting 5 gr. A.S.A. detonators	-
10. 2.42	Accidentally dropping tray of 5 gr. A.S.A. detonators	-
9. 9.42	Filling Naval 5 gr. A/Z detonators	F.94
7.11.42	Pressing time ring for Fuze No.400	-
1. 1.43	Filling caps No.12 Mk.3 with A.1 Composition	F.113
4. 2.43	Filling 5 gr. A/Z detonators by auto machine	-
10. 3.43	Thread gauging on fuze No.117 Mk.3.A	-
11. 3.43	Extracting 5 gr. A/Z detonators	F.139
14. 3.43	Brushing surplus azide from filled 246 sleeve assemblies	-
1. 4.43	Filling 5 gr. A/Z detonators	F.156
21. 4.43	Filling 1.7 gr. detonators with A.1 composition	F.158
15. 5.43	Filling caps No.12 Mk.3 with A.1 composition	F.165
8. 6.43	Internally cleaning 5 gr. A/Z detonators	F.170
21. 7.43	Externally cleaning 5 gr. A/Z detonators	F.177
10. 8.43	Filling caps No.12 Mk.3 with A.1 Composition	F.184
13. 8.43	Transferring 1.7 grain dets. from carrying box	F.185
15. 8.43	Extracting tight sleeve from Tracer Igniter No.14	F.186
17. 8.43	Filling 5 gr. A/Z detonators	F.187
6. 9.43	Pressing 46 gr. G.20 pellets	F.194
4.10.43	Externally cleaning 5 gr. A/Z detonators	F.200
12.10.43	Destroying picric pellets on Burning Ground	-
23.11.43	Externally cleaning 6 gr. Z/Y detonators	F.218
4.12.43	Drumming 4 gr. Z/Y detonators	F.219
30.12.43	Externally cleaning 5 gr. A/Z detonators	F.224
20. 1.44	Destroying waste C.E. pellets on the Burning Ground	F.226
1. 2.44	Visual examination of 5 gr. A/Z detonators	-
28. 2.44	Drumming 10 gr. fulminate detonators	F.241
15. 3.44	Closing 2.8 gr. A/Z detonators	-
22. 3.44	Pressing stars for 1.1/2-in. signal green ctge.	F.254
31. 3.44	Drumming 2.8 gr. A/Z detonators	F.260
3. 5.44	Externally cleaning 5 gr. A.S.A. detonators	-
9. 5.44	Grading 1.7 grn. detonators	-
13. 5.44	Internally varnishing 5 gr. A/Z detonators	-
2. 9.44	Filling caps No.16 Mk.1	-
11. 9.44	Externally cleaning 6.7 gr. A/Z/Y detonators	F.282
23. 9.44	Externally varnishing 6.7 gr. A/Z/Y detonators	-
27. 9.44	Pressing smoke containers No.3 Mk.2	F.285
18.10.44	Pressing candles for 7-in. hooded flare	-
1.11.44	Filling 5 gr. A.S.A. detonators	-

Date	Operation during occurrence of Explosion or Fire	Circulation No.
2. R.F.F. Bridgend (contd)		
6.12.44	Visually examining 5 gr. A/Z detonators	-
1. 2.45	Finally inspecting 5 gr. A.S.A. detonators	F.309
18. 4.45	Externally cleaning 1.7 gr. detonators	F.319
1. 5.45	Filling 5 gr. A.S.A. detonators	F.325
6. 5.45	Destroying A.S.A. composition	F.331
3. R.F.F. Glascoed		
31. 5.41	Pressing 2 pdr. Mk.1 Shell	F.11
4. 2.42	Mixing smoke composition P.N.83	F.40
26. 1.42	Incorporating T.N.T./B.W.X. in Edge Runner Mill	F.45
12. 3.42	Mixing smoke composition P.N.83	F.59
4. 4.42	Removing D.N.P. from melting pan	F.58
5. 4.42	Removing "lagging" from shellite melting copper	F.58
3. 9.42	Transporting N.C.T. from magazine to workshop	148/42
23. 2.44	Removing tracer No.11 from 40 m.m. T.N.T. shell	F.242
20. 8.45	Filling and pressing Grenades No.83	F.336
4. R.F.F. Hereford		
3. 8.41	Fuzing 3-in. S.B. projectile with Allways fuze	-
19.12.41	Removing 1.3/4-oz. Red Phos. Smokebox from 5.5-in. shell	-
8. 7.42	Destroying Minol, T.N.T. and Amatol waste	127/42
5. R.F.F. Swynnerton		
9. 6.41	Filling 20 m.m. caps	F.12
21. 8.41	Sieving S.R.227	-
1.12.41	Filling 6 gr. Z/Y detonators	-
24. 9.42	Burning waste amatol	F.88
20. 1.43	Externally varnishing 6 gr. Z/Y detonators	-
20. 2.43	Extracting 20 m.m. caps	F.136
3. 7.43	Filling 20 m.m. caps	F.178
11. 8.43	Pressing 9 m.m. caps	F.190
16. 8.43	Extracting 6 gr. Z/Y detonators	F.191
3. 9.43	Closing 5 gr. Z. detonators for proof purposes	F.198
6. 9.43	Extracting 6 gr. Z/Y detonators	F.199
26.10.43	Closing 5 gr. Z detonators for proof	F.212
9.12.43	Filling 6 gr. Z/Y detonators	F.220
12. 3.44	Filling and pressing tracer bullets	-
24. 4.44	Closing 6 gr. Z/Y detonators	F.273
27. 4.44	Drumming 6 gr. Z/Y detonator	-
12. 6.44	Extracting 6 gr. Z/Y detonators	F.280
5.12.44	Extracting 6 gr. Z/Y detonators	-
6. R.F.F. Risley		
1. 2.42	Sieving R.D. 202	F.32
3. 6.42	Preparing 2-in. T.M. Smoke bombs for destruction	F.69
28. 6.42	Drumming 4 gr. Z/Y detonators	F.74
17. 7.42	Externally cleaning 5 gr. A.S.A. detonators	F.79
26. 8.42	Grading 5 gr. A.S.A. detonators	F.81
18. 9.42	Grading 5 gr. A.S.A. detonators	F.91
21.10.42	Pressing and rectifying 2-in. T.M. Smoke bombs	F.97

Date	Operation during occurrence of Explosion or Fire	Circulation No.
6.	R.F.F. Risley (contd)	
26.10.42	Internally varnishing 5 gr. A.S.A. detonators	F.98
6.11.42	Sifting lead azide	F.107
23.11.42	Closing 5 gr. A.S.A. detonators	-
30.11.42	Sieving potassium chlorate and charcoal for P.N.196	F.110
1.12.42	Gauging 5 gr. A.S.A. detonators	F.116
2.12.42	Gauging 5 gr. A.S.A. detonators	F.116
15.12.42	Closing 5 gr. A.S.A. detonators	F.117
21.12.42	Grading 5 gr. A.S.A. detonators	F.118
7. 1.43	Examining 5 gr. A.S.A. detonators	-
18. 1.43	Extracting 5 gr. A.S.A. detonators	F.125
17. 2.43	Milling R.D.202	F.147
2. 3.43	Finishing 5 gr. A.S.A. detonators	F.134
4. 3.43	Internally varnishing 5 gr. A.S.A. detonators	F.137
29. 3.43	Filling 5 gr. fulminate boosters	F.141
11. 4.43	Tracering 2 pdr shot	F.159
20. 4.43	Extracting 6 gr. Z/Y detonators	F.161
24. 7.43	Finishing 4 gr. Z/Y detonators	F.181
26.10.43	Pressing lead azide proof detonators	-
2.12.43	Internally cleaning 6 gr. Z/Y detonators	-
30.12.43	Extracting 6 gr. Z/Y detonators	F.223
1. 2.44	Extracting fuze No.251 sleeves from moulds	F.234
29. 2.44	Drumming 6 grn. Z/Y detonators	-
12. 4.44	Cleaning lead azide filling machine	F.265
18. 9.44	Closing 4 gr. Z/Y detonators	-
19. 9.44	Storing ballistite ctges. etc.	-
5.10.44	Precipitating lead azide	F.289
5.11.44	Destroying Minol waste	F.293
5. 2.45	Closing smoke containers yellow No.4	F.310
7.	R.F.F. Kirkby	
29. 4.42	Drumming 5 gr. A.S.A. detonators	F.62
4. 5.42	Externally varnishing 4 gr. Z/Y detonators	F.61
27. 8.42	Assembling 6 pdr. A.P. ctges to shot	F.83
11. 9.42	Filling 5 gr. A/Z detonators	F.90
21. 9.42	Pressing 2-in. T.M. bombs	F.95
6.11.42	Breaking down fuze No.720 Mk.IV	-
19. 5.43	Filling 1.7 grain detonators	F.179
7. 9.43	Precipitating lead azide	F.204
19. 1.44	Assembling 2-in. T.M. stars for pressing	F.232
19. 1.44	Internally varnishing 5 gr. A/Z detonators	-
13. 2.44	Spontaneous ignition of 40 m.m. Innocuous shell	F.239
16. 2.44	Spontaneous ignition of 40 m.m. Innocuous shell	F.239
26. 2.44	Filling first increment 5 gr. A/Z.	F.247
20. 3.44	Rumbling 4 gr. Z/Y detonators	-
29. 3.44	Rumbling 4 gr. Z/Y detonators	-
29. 3.44	Assembling shutter of fuze No.152	-
29. 3.44	Assembling shutter of fuze No.152	-
14. 6.44	Cutting 4-in. A/S flare candles	F.279
15. 7.44	Cutting 4-in. A/S flare candles	-
27. 4.45	Pressing candles for 2-in. Signal star red	-
7. 5.45	Pressing 4 oz 6 dr C.E. Pellets	-
18. 6.45	Filling U.P. igniters with S.R.371 C	F.332
19. 7.45	Filling and pressing tracer	F.334

Date	Operation during occurrence of Explosion or Fire	Circulation No.
8. R.F.F. Thorp Arch		
15. 2.42	Sieving lead azide	F.36
16. 9.42	Filling 20 m.m. Caps	F.84
20.10.42	Filling 0.5-in. Browning bullets	153/42
11. 4.43	Closing 20 m.m. caps with paper discs	F.154
15. 4.43	Internally cleaning 5 gr. A/Z detonators	F.151
19. 5.43	Cutting back S.R.365 in 0.5-in. Browning bullets	F.166
16. 6.43	Filling 5 gr. A/Z detonators	F.169
26. 8.43	Pressing 5 gr. lead azide proof detonators	-
6. 9.43	Pressing S.R.372 pellets	-
10. 3.44	Assembling 20 mm H/S S.A.P./I rounds	F.250
14. 3.44	Filling 6 gr. Z/Y detonators	-
24. 4.44	Weighing out 'A' composition	F.266
25. 7.44	Extracting 5 gr. lead azide detonators	-
24. 8.44	Dropping pot of 'A' composition accidentally	F.281
9. R.F.F. Aycliffe		
7.10.41	Removing waste A.S.A. composition from bucket	-
15.10.41	Counting 5 gr. A.S.A. detonators	-
30. 4.42	Collecting 5 gr. A.S.A. detonators for destruction	F.51
10. 5.42	Mixing A.1 composition	F.54
25. 5.43	Filling 0.5-in. Browning caps	-
15.10.43	Sieving lead azide	F.206
31.12.43	Precipitating lead azide	F.222
4. 2.44	Mixing smoke composition S.R.269	F.233
21. 2.44	Filling S.R.365 into 0.5-in. Browning bullets	F.238
25. 2.44	Extracting 6 gr. Z/Y detonators	-
29. 2.44	Extracting 6 gr. Z/Y detonators	F.243
3. 3.44	Closing 6 gr. Z/Y detonators	-
15. 3.44	Rectifying parchment disc on 20 m.m. cap	-
1. 5.44	Cleaning drain at lead azide plant	F.267
10. 5.44	Extracting 6 gr. Z/Y detonators	-
18. 5.44	Assembling fuze No.390 ring for pressing	F.270
21. 6.44	Granulating S.R.458 composition	-
22. 9.44	Destroying contaminated waste	F.283
25.10.44	Springing in shutter assembly of fuze No.161	F.291
5. 4.45	Breaking down fuze No.162	-
10. 4.45	Packing fuzes No.222	F.316
17. 4.45	Handling detonators with fingers	F.322
10. 6.45	Pressing S.R.227 pellets for tubes P.S.A.	-
18. 7.45	Dismantling a tracer filling cubicle	-
10. R.F.F. Healey Hall Mill		
1.10.41	Assembling 3-in. T.M. Bomb cartridge	F.20

D. Accidents in which no Court of Enquiry was held.

Date	Operation during occurrence of Explosion or Fire	Circulation No.
1. R.F.F. Chorley		
30.12.42	Externally cleaning 5 gr. A.S.A. detonators	
1. 1.43	Externally cleaning 5 gr. A.S.A. detonators	

Date	Operation during occurrence of Explosion or Fire	Circulation No.

1. R.F.F. Chorley (Contd)

1. 1.43	Externally cleaning 5 gr. A.S.A. detonators	
25. 1.43	Filling 6 gr. fulminate detonators	
4. 2.43	Handling 5 gr. A.S.A. detonators	
15. 5.43	Removing fuze No.222 from proof apparatus	
6. 7.43	Experimental work on 5 gr. A.S.A. detonators	
4.12.43	Closing 4 gr. Z/Y detonators	
10. 1.44	Extracting 5 gr. A.S.A. detonators	
6. 3.44	Filling 5 gr. A/Z detonators	
24. 8.44	Drumming 5 gr. A.S.A. detonators	

2. R.F.F. Bridgend

26. 7.41	Proofing Gaines No.12	
15. 8.41	Cleaning lead styphnate filling machine	
16. 1.42	Gauging 5 gr. A.S.A. detonators	
26. 1.42	Fuze No.243 while standing in a rack	
9. 2.42	Extracting bottom ring from fuze 198	
19. 1.43	Preparing fuze No.420 for proof	
21. 3.43	Testing detonator channel of fuze No.400	
8.11.43	Pressing candles for 7-in. Hooded Flare	
12. 7.44	Transferring detonators from carrying to transit box	
21.11.44	Drumming 5 gr. A.S.A. detonators	
2. 3.45	Drumming 5 gr. A.S.A. detonators	

3. R.F.F. Glascoed

14.12.41	Detonators for Grenade 75 exploded in truck	
22. 2.44	Pressing PN.443 into 25 pdr. smoke containers	

4. R.F.F. Swynnerton

10. 7.41	Transferring detonators from one bench to another	
16. 1.42	Filling 6 gr. detonators	
12. 2.42	Pressing 2-in. T.M. Bomb	
29.12.42	Rectifying Oer. HE/I/T round	
18. 5.43	Pressing 6 gr. fulminate detonators	
24. 5.43	Filling 6 gr. Z/Y detonators	
27. 7.43	Extracting filled tracer bullet	
18.10.43	Assembling 20 m.m. Oer rounds	
26.10.43	Finishing reject 6 gr. Z/Y detonators	
11.11.43	Setting-down H/S.HE/I shell	

5. R.F.F. Risley

18. 2.42	Explosion of 5 gr. A.S.A. detonators	
22. 4.42	Explosion of 5 gr. A.S.A. detonators	
30. 4.42	Extracting 5 gr. A.S.A. detonators	
13. 5.42	Counting 4 gr. Z/Y detonators	
21. 9.42	Transporting 2-in. T.M. Smoke Bomb.	
14. 1.43	Examining 5 gr. A.S.A. detonators	
1.11.44	Precipitation of lead azide	
20. 2.45	Joggling 6 gr. Z/Y detonators	

Date	Operation during occurrence of Explosion or Fire	Circulation No.

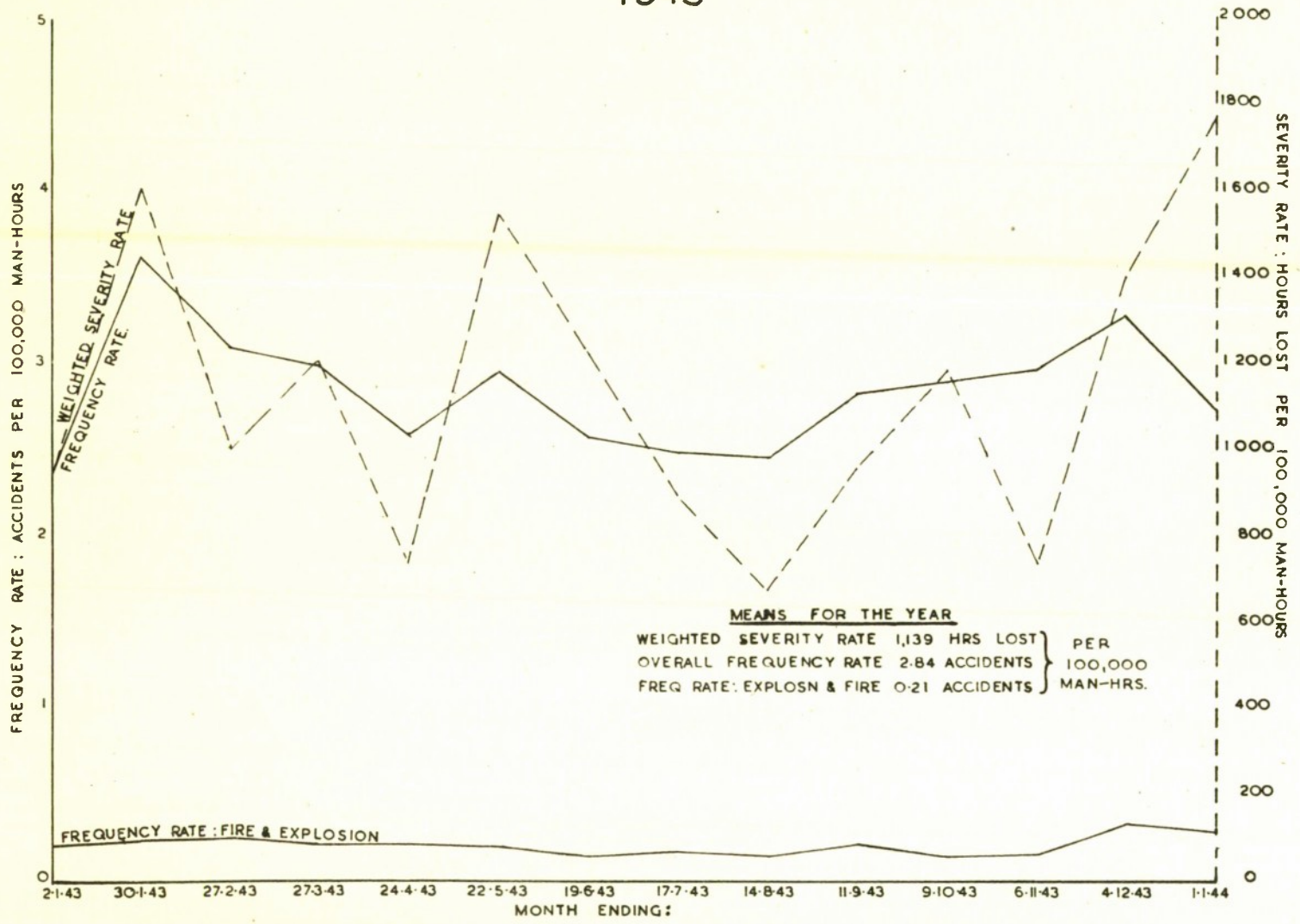
6. R.F.F. Kirkby

28. 7.44 Rectifying cavity of 500-lb. bomb

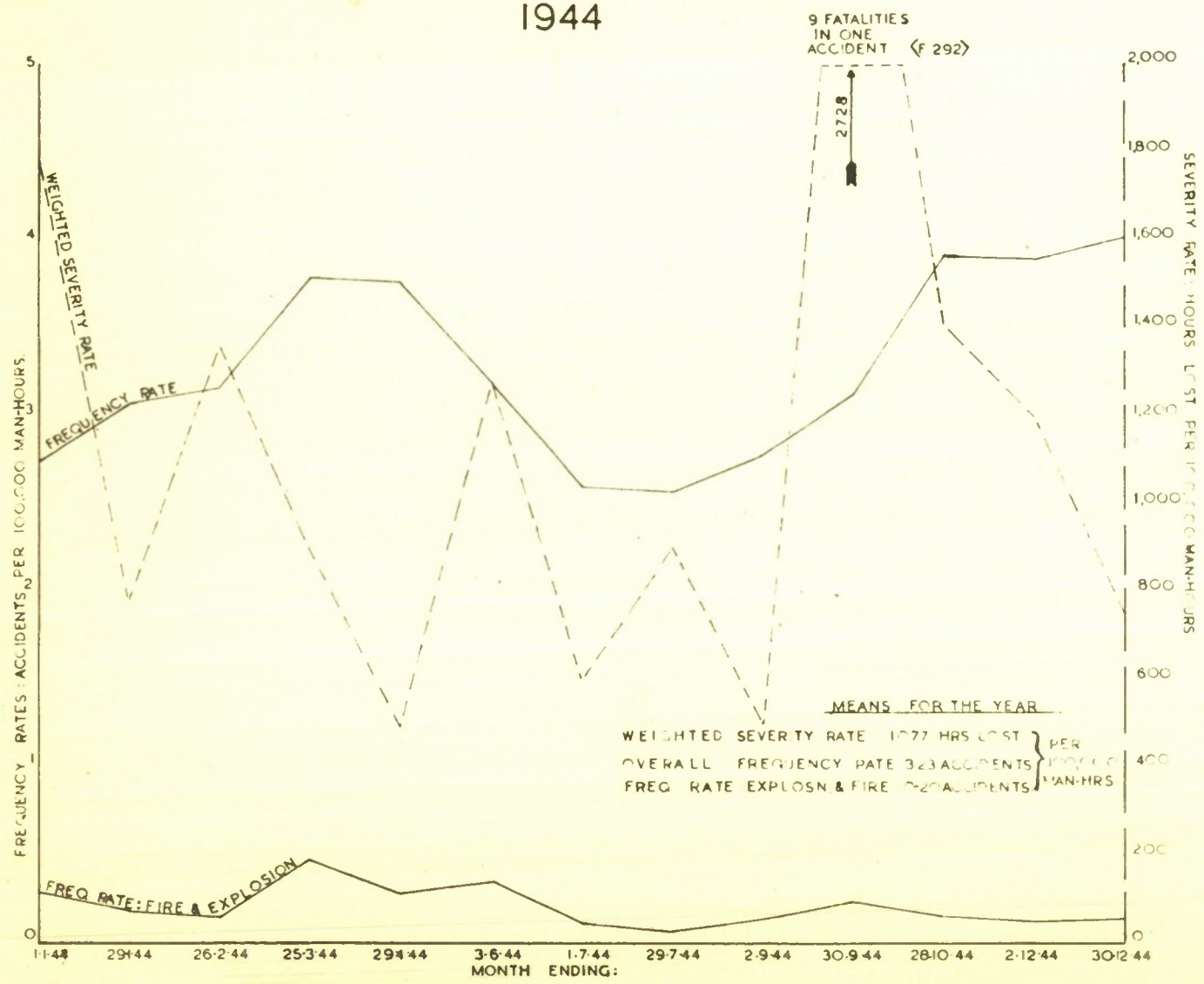
7. R.F.F. Thorp Arch

23. 1.43 Proofing 20-m.m. HE/I rounds
2. 6.43 Extracting 6 gr. fulminate detonators
19. 8.43 Pressing caps for 20-m.m.
19. 9.43 Filling 0.5-in. Browning incendiary bullets
10.12.43 Incorporating minol
2. 3.44 Pressing caps for 20-m.m.

ROYAL FILLING FACTORIES
ACCIDENT STATISTICS SUMMARY
1943



ROYAL FILLING FACTORIES
ACCIDENT STATISTICS SUMMARY
1944



APPENDIX M

Royal Filling Factories

Fatalities

1st January 1941 to 31st July 1945

Total 90 (including 11 Inspectorate)
Men 51 (including 5 Inspectorate)
Women 39 (including 6 Inspectorate)

Filling Factory Operatives 46 Men 33 Women
Inspectorate Operatives 5 Men 6 Women

Segregated according to Factories this is:-

R.F.F.	R.F.F. Operatives		Inspectorate Personnel		Total
	Men	Women	Men	Women	
Chorley	3	3	-	1	7
Bridgend	7	6	4	-	17
Glascoed	2	-	-	-	2
Hereford	8	-	-	-	8
Swynnerton	10	2	-	1	13
Risley	4	1	-	-	5
Kirkby	4	10	1	3	18
Thorp Arch	1	1	-	1	3
Aycliffe	7	10	-	-	17
TOTAL	46	33	5	6	90

Year by year analysis gives:-

Year	R.F.F. Operatives		Inspectorate Personnel		Total
	Men	Women	Men	Women	
1941	10	7	-	1	18
1942	10	14	1	-	25
1943	7	2	2	2	13
1944	7	7	1	3	18
1945 (7 mos.)	12	3	1	-	16
TOTAL	46	33	5	6	90

The above statistics are compiled from reports by teleprint to D.G.F.F. in accordance with Filling Factory Instructional Memo. No.225.

for D.F.F. (Production)

22.8.1945

APPENDIX N

ROYAL FILLING FACTORIES

Accident Statistics Summary

Period 5.12.1942 to 1.1.1944

Factory	Frequency Rate Accidents per 100,000 man-hrs.	Weighted Severity Rate Hours lost per 100,000 man-hours	Frequency Rate Fire and Explosion
Chorley	2.80	1321	0.167
Bridgend	1.85	862	0.257
Glascoed	4.18	1338	0.000
Hereford	4.18	1112	0.001
Swynnerton	2.48	1389	0.209
Risley	2.87	1363	0.224
Kirkby	2.46	1206	0.175
Thorp Arch	2.51	323	0.225
Aycliffe	3.80	1006	0.405
True Average	2.84	1139	0.214

Analysis of Injury Causes

Injury Cause	Frequency Rate Accidents per 100,000 man-hrs.	Percentage of all accidents
1. Machinery in motion	0.096	3.4
2. Vehicles (except man-propelled)	0.052	1.9
3. Electricity, hot or corrosive substances	0.048	1.7
4. Falls of persons	0.875	30.7
5. Persons striking against objects	0.289	10.2
6. Handling objects (other than hand-tools) including man-propelled vehicles	0.520	18.3
7. Falling objects	0.509	17.9
8. Use of hand-tools	0.067	2.4
9. Miscellaneous	0.170	6.0
10. Fire and Explosion	0.214	7.5
TOTAL	2.840	100.0

21.9.1945.

The above figures do not include "Contact"

(Sgd.) G.Davies
for D.F.F. (Production)

ROYAL FILLING FACTORIES

Accident Statistics Summary

Period 2.1.1944 to 30.12.1944

Factory	Frequency Rate Accidents per 100,000 man-hrs.	Weighted Severity Rate Hours lost per 100,000 man-hours	Frequency Rate Fire and Explosion.
Chorley	2.71	936	0.09
Bridgend	2.16	814	0.31
Glascoed	3.87	1177	Nil
Hereford	4.51	2312	0.45
Swynnerton	3.57	698	0.25
Risley	3.53	824	0.14
Kirkby	3.33	3021	0.29
Thorp Arch	3.32	333	0.14
Aycliffe	3.74	936	0.25
True Average	3.22	1113	0.203

Analysis of Injury Causes

Injury Cause	Frequency Rate Accidents per 100,000 man-hrs.	Percentage of all Accidents
1. Machinery in motion	0.106	3.3
2. Vehicles (except man-propelled)	0.044	1.4
3. Electricity, hot or corrosive substances	0.093	2.9
4. Falls of persons	0.956	29.7
5. Persons striking against objects	0.344	10.7
6. Handling objects (other than hand-tools) including man-propelled vehicles	0.691	21.5
7. Falling objects	0.563	17.5
8. Use of hand-tools	0.049	1.5
9. Misoellaneous	0.167	5.2
10. Fire and Explosion	0.203	6.3
TOTAL	3.216	100.0

14.3.1945

The above figures do not include "Contact"

(Sgd.) G.Davies
for D.F.F. (Production)

APPENDIX O

ABSTRACT

An account is given of the development of a material for the production of sewing machine needles used on cordite bags which would be suitable from the point of view of ease of fabrication and non-sparking characteristics.

I - INTRODUCTION

In July 1941 S.T.A.M. was asked by A.D.O.F.(F) to investigate the possibility of obtaining sewing machine needles in a non-ferrous material.

The needles were required for use on plants for weighing, filling and closing of 25 pr. N.C.T. cartridge bags, and it was felt desirable to use non-ferrous needles in order to avoid the risk of sparking. It was agreed to examine the question of suitable materials, and arrange for samples to be made and tested, on the basis of which a production order would be placed.

II - OBJECT

The object of the investigation was to develop a sewing machine needle which would be free from risk of sparking when used to sew filled cordite bags.

III - METHOD

A fishing needle manufacturing company - The Torrington Company Ltd. - was approached with regard to the preparation of sample needles from suitable non-ferrous wire. Subsequent negotiations took place chiefly with the Coventry Swaging Co., an associate of The Torrington Co.

It was clearly necessary that the alloy chosen should be not only non-sparking but also sufficiently hard to give a useful service life. Two materials were initially suggested: K-Monel and Everdur (K-Monel is monel metal containing about 2.1/2% aluminium, which renders the alloy susceptible to heat treatment: a maximum Brinell Hardness of about 350 can thus be obtained. Everdur contains 96% Cu, 3% Si, 1% Mn.) The co-operation of the British Non Ferrous Metals Research Association was sought in obtaining experimental quantities of K-Monel and Everdur but discussions with the firm suggested that these materials might be unsuitable and beryllium copper was put forward as an alternative.

The needles have a groove running the full length and an eye near the point. The Torrington Co., expressed the view that Everdur would be liable to chip during grooving, and would in any case be too soft. The proposal to use this alloy was therefore dropped. Tests on K-Monel wire disclosed that the material hardened excessively on swaging, and grooving became too difficult an operation. Beryllium copper was satisfactory in this respect, and several needles were made and heat treated, and sent to I.C.I. (Salt) Ltd. for test. The hardness of the needles was 320 Vickers. Unfortunately the trial was a failure, since the needles had been made to the wrong design. However one needle was modified to enable it to sew, and successfully passed a 2-hour endurance test. But this result was not borne out by further trials on a different fabric, blunting being experienced. It was decided to have a fresh batch of needles made to correct dimensions in order that a fair test could be carried out. These proved successful, and were then submitted to a more prolonged test at an R.O.F. The needles had an

endurance of 2 - 2.1/2 days, and were considered satisfactory. (The life of steel needles is not known). Arrangements were then made for the supply of a bulk quantity (several gross) for production work.

IV - RESULTS

A non-sparking sewing machine needle has been developed which can be fabricated without undue difficulty and which has satisfactory endurance.

SUMMARY

The department was asked by A.D.O.F. to develop non-sparking needles for cordite bags. Three alternative non-ferrous alloys were investigated; Everdur, K-Monel and beryllium copper. Of these beryllium copper alone proved suitable from the production aspect. This alloy was also found to behave successfully in sewing trials.

ACKNOWLEDGEMENT

It is desired to acknowledge the co-operation of the British Non Ferrous Metals Research Association in this investigation.

Reference can be made to M. of S. File Ref. No.287/Met/36 "Non-Sparking needles for Cordite bag sewers"

[dstl]

Information Centre
Knowledge Services
[dstl] *Porton Down,*
Salisbury
Wilts
SP4 0JQ
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
U.S.A.

AD#:
Date of Search: 16 February 2007

Record Summary:

Title: Safety in Royal Filling Factories
Covering dates 1950
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) 15.350
Held by The National Archives, Kew

This document is now available at the National Archives, Kew, Surrey, United Kingdom.

DTIC has checked the National Archives Catalogue website (http://www.nationalarchives.gov.uk) and found the document is available and releasable to the public.

Access to UK public records is governed by statute, namely the Public Records Act, 1958, and the Public Records Act, 1967.
The document has been released under the 30 year rule.
(The vast majority of records selected for permanent preservation are made available to the public when they are 30 years old. This is commonly referred to as the 30 year rule and was established by the Public Records Act of 1967).

This document may be treated as UNLIMITED.